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PAPERS FOR DISCUSSION

AT THE

MEETING OF THE BRITISH ASSOCIATION.

PAPERS

OFFERED FOR DISCUSSION

AT THE

MEETING OF THE BRITISH ASSOCIATION

AT DUNDEE,

IN REPLY TO THE SPECULATIONS RECENTLY PROMULGATED IN REGARD
TO THE ANTIQUITY AND NATURE OF MAN.

BY THE

REV. JAMES BRODIE, A.M.

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TO HIS GRACE

THE DUKE OF BUCCLEUCH, &c.,

THE PRESIDENT,

AND OTHER OFFICE-BEARERS AND MEMBERS OF THE

British Association for the Advancement of Science.

My Lords and Gentlemen,

At the Meeting of the British Association held at Newcastle, the President, in his Inaugural Address, told us, that "it seems no longer possible to doubt that the human race has existed on the earth, in a barbarian state, for a period far exceeding the limit of the historical record." At the same time, the leading members of the Association expressed their concurrence in the statement of the President, and Sir Charles Lyell, the principal exponent of the modern views in regard to the Antiquity and Nature of Man, was elected President for the following year.

At Bath similar opinions were advocated in the same manner. Last year, at Nottingham, the President, Mr Grove, in his Introductory Address, pursued a similar course.

Many persons have consequently been led to regard the Association as having given its authority and sanction in support of the hypotheses which are advocated by Sir Charles in his work on the "Antiquity of Man."

In these circumstances, those who continue to entertain the opinions that formerly prevailed, may be pardoned if they think that they are entitled to be heard before the Association in support of their views.

Having, therefore, been at some pains to test the accuracy of the evidence adduced by the supporters of the modern hypothesis, and having found that evidence, as I believe, to be undeserving of confidence, I have embodied the result of my investigations in the accompanying Papers; which I now offer for discussion at the Meeting of the Association to be held at Dundee.

All I ask is a patient hearing and an impartial decision.

I remain,

Your obedient Servant,

JAMES BRODIE.

MONIMAIL, 22*d* *August* 1867.

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ON THE

ORIGIN AND GROWTH OF PEAT.

HITHERTO, the subject which I have indicated does not seem to have received the examination necessary for forming any very definite opinion in regard to it. When, for instance, we turn to the article *Peat*, in the various Encyclopædias that have been published, we find the writers agree in saying, that it is produced by the decay of vegetable matter, and that it grows, or gradually accumulates; but no one seems to have directed any special attention to the conditions under which it originates, or to the circumstances that regulate its increase. The Edinburgh Encyclopædia says, "On the nature and origin of peat, philosophers are much at variance, and the discordant opinions entertained by them, induce us to think that very little real knowledge of its nature and properties has hitherto been acquired." These words were written in 1830; but they seem to be as applicable to the present as to any former time.

One of the most recent of the theories in regard to the origin and growth of peat which have been brought before the public, is that of M. Boucher de Perthes, as adopted, with some slight modification, by Sir C. Lyell in his work on the "Antiquity of Man." His statement, as given in his description of the Valley of the Somme, is as follows:—

> "Newer than these is the peat, which is from ten to thirty feet in thickness. This substance occupies the lower part of the valley far above Amiens, and below Abbeville as far as the sea. It has already been stated to be in some places thirty feet thick, and is even occasionally more. . . . The peat in the Valley of the Somme is a formation which in all likelihood took thousands of years for its growth. . . . It belongs to the Recent Period, all the embedded mammalia, as well as shells, being of the same species as those now inhabiting Europe.
>
> "The workmen who cut peat, or dredge it up from the bottoms of swamps and ponds, declare that in the course of their lives none of the hollows which they have found, or caused by extracting peat, have ever been refilled, even to a small extent. This, as M. Boucher de Perthes observes, is a mistake; but it implies that the increase in one generation is not very appreciable by the unscientific."

According to this extract, these gentlemen seem to entertain the idea that peat either grows at the bottom of pools, or is the effect of a very slow process, like that spoken of by Dr Forschammer, and quoted by Sir Charles in another part of his work, who tells us, that water charged with vegetable matter in solution, throws down a deposit of peat through the action of frost.

As I do not concur in this opinion, I shall adduce some of the reasons which lead me to reject the conclusions to which these philosophers have come. In doing so I shall, in the first place, direct attention to the origin and nature of peat, and then to its growth, or rate of increase.

ORIGIN AND NATURE OF PEAT.

In those places where peat has accumulated to a depth of two or three feet, we usually find immediately under the surface of the ground the decaying roots and stems of plants that naturally grow in such situations. Intermingled among them is a quantity of a black, or dark brown substance, which may be separated from the fibrous matter around it by the application of water, through which it is easily diffused. The proportionate quantity of this substance increases as we descend to the bottom of the morass, while the quantity of the decaying fibre is diminished.

This substance is *peat*, in the more restricted sense of the term; though the word is frequently employed to designate the whole mass of peat and vegetable fibre that is dug from the bog and moor.

In its nature, *peat* presents in many respects a remarkable contrast to the *humus*, or vegetable mould which is produced by the ordinary decay of plants. *Humus*, when moistened and collected into heaps, begins very soon to putrefy, it gradually passes away in a gaseous form, and leaves at last but a small earthy residuum behind. When spread out on the ground, and left exposed to the influence of the weather, its decay is not so rapid as when it is moistened and gathered into heaps; but the end is the same. It is transformed into a variety of gaseous combinations, and wastes almost entirely away. In America, after forests have been cut down, the ground is sometimes found covered with vegetable mould to the depth of several feet. For a time this soil is exceedingly fertile; but after some years cultivation the thickness of the mould and the fertility of the soil alike diminish, so that the farmer has either to remove to another farm, or to supply by the application of manure the place of the mould that has rotted away. This perishable nature of vegetable mould presents a striking contrast to the enduring character of peat. If we take a quantity of pure black peat, such as we find at the bottom of our morasses, after the humus that may have been mixed with it has passed away, whether we gather it into heaps, or spread it out to the air, whether we expose it to the summer's heat or to the winter's cold, it seems to undergo no decomposition. Some small part of it may be washed away by the rain; but its nature, in so far as we can judge, continues the same.

In its appearance it resembles the powder of charcoal, and partakes of its antiseptic and purifying properties. The bodies of animals which have been embedded in peat remain for a long time without decay, and while the water in the ponds and streams which derive their supplies from the fields and pasture grounds of the low country are commonly loaded with impurities, the water that flows over a peaty soil, when the floating peat has subsided, is comparatively pure.

The water brought into Glasgow, for example, from the peat producing hills around Loch Katrine, contains only three parts of extraneous matter out of a hundred thousand. I cannot, therefore, look on peat as a mere variety of vegetable mould, as some have affirmed it to be, but must regard it as a substance possessing distinct and peculiar properties, into which the fibres and tissues of the plants which produce it have been transformed. It is, however, by no means easy to determine what the circumstances are under which this transformation proceeds.

My own examination into the subject leads me to conclude, that, in general, the transformation commences in the bark or skin of the underground parts of the plants. In some of those roots, which from their size allow us to trace more easily the process of change, we find that even when the central part appears to be fresh, the bark has been converted into peat. I first remarked this circumstance in the rhizoma, or underground stem, of the Marsh Fern, *Lastrea Thelypteris.*

Many of these roots, even when they have been transformed into peat, retain to a considerable extent their former shape. Some roots of a larger size and spongy texture, such as those of the Marsh Trefoil, *Menyanthes Trifoliata*, have their bark transformed into a substance that resembles coal; while the interior is filled with a soft pulpy moss. When they are pressed together by the weight of matter that accumulates above them, these larger roots thus changed may be not inaptly compared to ribbons of black silk.

Geologists, I may remark in passing, are aware that the stigmaria and other marsh loving plants of former eras, exhibit evidences of having undergone a similar transformation.

In so far as I have been able to ascertain, peat, in the restricted sense of the term, is produced by the decay of the underground parts of a particular class of plants. We find among these plants representatives of almost every order and genus of terrestrial vegetation, though the lichens and mosses seem to be the most abundant. The plants are generally indigenous to moist and boggy ground; but wherever they can vegetate, whether the ground be moist or dry, occasionally at least, they manifest their peat producing tendency. If we pull up the stem of the Horse-tail, *Equisetum*, growing in the thoroughly drained and cultivated field, we find the underground bark covered with what appears to be a film of incipient peat. The marsh fern, to which I before referred, was taken from a small collection of British ferns, in a shaded and sheltered situation, but in a soil that was more than usually dry.

On one occasion I observed that a plant of the globe flower, *Trollius Europeus*, which for several years had occupied a place in the flower border, and had in that time formed a matted turf several inches in thickness, had been affected by a blight, by which the greater part of the plant had been killed. On lifting the part decayed I found it almost entirely changed into a substance very closely at least resembling peat, and I then recollected that the globe flower frequently constitutes no inconsiderable portion of the flora of our marshy grounds.

While the class of plants, to which I have referred, manifest a peat producing tendency, in whatever situation they may grow, the other members of the vegetable kingdom, in their decay, are formed into vegetable mould, and do not appear in any circumstances to produce peat.

In this latter class I include, though not without some hesitation, our forest trees, even those which are most frequently found preserved in our mosses. I have remarked that those trees show no sign of transformation into peat, unless when they are embedded in peat, or are surrounded with peat producing plants. I have sometimes seen their bark covered with what seemed to be a thin coating of peat; but was led to conclude, on closer examination, that this covering had been produced by the decay of the mosses and lichens which had grown upon them, rather than by any direct transformation of the bark itself. Even when those trees are found completely blackened by the peat which covers them, their timber has all the appearance of ordinary rotten wood excepting its colour. Dr Walker, Professor of Natural History in Edinburgh University, published, about the year 1800, an Essay on Peat. Some of his theories in regard to the purposes to which peat may be applied are, perhaps, rather fanciful; but his observations on facts are the result of careful and extensive research, and are, therefore, very valuable.

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Dr Macculloch, in his Essay on Peat, published in the Edinburgh Philosophical Journal, says —

"During the growth of a forest in favourable situations, a stratum of peat is formed by the accumulation of decaying leaves and branches, and by the growth and conversion of the plants which grow under their shade. The smaller branches, and even the larger, being exposed for a longer period to the effects of air and water, are ultimately converted into peat, while in a few instances, even the trunks disappear."

With all due deference, however, to the authority of Dr Macculloch, I still retain the opinion, that the decaying leaves and branches of forest trees produce nothing but vegetable mould, and that it is only indirectly that they contribute to the growth of peat, by the shelter and nourishment which they afford to the peat producing plants that grow beside them.

DEPOSITS OF PEAT.

The deposits of peat are of two kinds. The first class consists of those that have been formed on the land, by the decay of plants that have grown on the spot wh[illegible] are found. These have been termed by [illegible] at le[illegible] natural strata of peat. I prefer the more descriptive name of *land formed peat.* We find them in our marshy hollows, and on our hills and moors. Their character and appearance depend on the nature of the plants that produce them, and on the locality in which they are formed. The peat which is produced by the *Sphagnum Palustre,* and similar varieties of moss, is light and spongy, and contains a large proportion of fibrous matter which has undergone but a partial decay. The deposit which is found on the sides of our mountains is produced from the heath, and from the grasses, lichens, and mosses, that flourish under its shelter. It is of a more solid texture than that which is produced from the sphagnum, and contains but little fibrous matter except the roots and stems of the heath. It seldom exceeds a few inches in thickness. This is to be attributed to two causes: to the bleak and exposed situation in which it is formed, which checks the growth of the peat producing plants; and to the effect of the rain, which carries off to the lower grounds a large proportion of the peat after it has been formed. The deposits found in the hollows between the hills have frequently embedded in them trunks and branches of the fir and birch, and other trees that grow in such situations. The peat that is found in the lower parts of the country differs in its consistency in different places. It contains the remains of reeds and rushes, as also of the oak and other trees, that grow in sheltered positions.

When peat has accumulated and is saturated with water, it forms a semifluid mass, and if the barriers

When speaking of timber found in deposits of peat, he says:—

> "In moss timber and other vegetable bodies found in peat, the cellular substance is nearly or entirely gone. It is only the fibrous part that remains. But this is always the case when wood has been putrid for a sufficient length of time, even in the open air."

Dr Macculloch, in his Essay on Peat, published in the "Edinburgh Philosophical Journal," says:—

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When peat has accumulated and is saturated with water, it forms a semifluid mass, and if the barriers that retain it give way, it flows out in a sluggish stream, and covers the adjacent ground.

> "The Solway Moss, in 1772, having been filled with water during some heavy rains, swelled to an unusual height above the surrounding country, and then burst, when a stream of black, half consolidated mud, began to creep over the plain, resembling, in the rate of its progress, an ordinary lava current. No lives were lost; but the deluge totally overwhelmed some cottages, and covered 400 acres. The height of the moss at the lowest part of the country which it invaded was at least fifteen feet." "An inundation in Sligo, in 1831, affords another example of this phenomenon."—*Lyell's* "*Principles of Geology,*" p. 701.

The second class of deposits consists of those that are formed under the water. They are produced by the decay of the equiseta and other plants whose roots are wholly submerged. They are found by the sides of ponds and rivers, and in shallow lakes. Along with the peat produced by the plants that grow in the locality where the deposit is collected, we usually find large quantities of vegetable matter brought by the water from other places. Where these deposits are connected with streams that flow through a peat producing district, we find considerable quantities of what we might term foreign peat. There are many cases in which the peat thus brought down forms the larger part, or, it may be, the entire mass of the deposit. Dr Walker, adopting a name given to these deposits by the country people, describes them as *water born peat.* He says:—

> "As peat earth is easily diffused in water and carried off,

wherever it comes again to be deposited we have water born peat. This abounds in Holland, where it is sometimes thirty feet deep; and it is even dredged out of some of the waters in that country for the purpose of fuel. It is frequent with us, and especially among the hills. Having been carried off by the rains and floods, it is deposited in hollow places, and there forms the greatest depth we have of peat earth, being frequently much deeper than any natural stratum of peat."

A peculiar class of deposits is referred to by Dr Rennie in his Essay on Peat.

"The submarine forests on the coasts of Lincolnshire are very extensive. They reach far into the German Ocean. In every respect they resemble the mosses at Hatfield and the adjacent fens. The wood is the same, though many of the trees are flattened by the incumbent weight of sand. Some are fastened to the original soil from which they sprang; the trunks of others are broken off. It is clear that these trees are not water born, but all remain in the spot on which they grew. Each trunk has its corresponding root attached to its native soil."

This is evidently the description of the remains of a moss, which had subsided, when its seaward boundary had been washed away. Similar instances of submergence are found on the shores both of Britain and the Continent.

Circumstances that lead to the Formation of Deposits of Peat.—Many of our deepest and most extensive deposits of land formed peat seem to have originated in the destruction of forests, either by the hand of man or by the violence of the wind. Dr Walker says:—

"That most of our deep and extensive peat mosses have been originally formed by the decay of ancient woods, appears from the following circumstances. We find in them large, full-grown trees, but always evidently broken over and without the bark. The trees found in our peat strata generally lie all in the same direction, giving a presumption of their having been blown over by the same wind. In the Locher Moss, and other extensive mosses in the West of Scotland, the trees all lie with their tops directed towards the north and north-east; and it is well known that all the great storms of wind on that side of the island come from the south and south-west. But the case is different in Holland. The tops of all the large trees that lie buried in the turf bogs there point to the south-west, for in that country all the highest gales of wind proceed from the north-east. Whereever trees fall, and are allowed to remain, they are immediately overgrown with mosses and herbage, and soon form a decaying mass. There was a great fall of trees in the Wood of Drumlanrig by the hurricane in the year 1754. As there was no demand for them in the country, they were suffered to remain and rot on the ground. In some places, where they were laid all in one direction, and very thick, they are now nearly ripened into peat earth."

In the "Statistical Account of Scotland" we find a variety of statements corroborating Dr Walker's observations. In Dr Rennie's Essay on Peat many similar facts are related. Dr Rennie also mentions, that in England the remains of the oak are most abundant when the subsoil is clay, while the fir prevails when the substratum is sand.

Dr Walker again remarks:—

"It appears from the inspection of many of our peat mosses, that the trees they contain have grown and been deposited at very different periods. The most obvious instance of this kind was observed in Strathcluony in Inverness-shire. This is a very high inland tract, being the watershed of the country between the two seas. It has formerly been a very extensive fir wood;

but there are now only some very old scattered trees standing in it. These have all flat bushy heads leaning to the east; but the trunks are large, and consist of the finest timber. This wood having worn out of itself, has left behind it a thick body of peat moss, formed during the long period of its growth and decay. Large roots of fir trees, which had evidently been broken off by the wind, were observed in this place. Some of these roots, with part of the trunk in its natural position, were seen at the bottom of the stratum, placed on the gravelly loam in which they had grown. But above this loam there was a stratum of peat, about three feet deep, evidently formed during the growth and decay of these trees. In some places the old roots of other fir trees were seen two or three feet immediately above the former, with their fangs spread horizontally, and having other three or four feet of peat above them. It is also clear that these roots must have belonged to trees of another generation, and of a date much posterior to the former. For they had only begun to grow after the trees on the loam had utterly decayed, and after three intervening feet of peat had been formed by their growth and decay. Again over these last roots, and situated about three or four feet deep in the peat earth, an aged fir was growing on the surface. There were here, then, three generations, or, as it were, tiers of trees, visibly placed one above another. This renders it probable that many of our deepest peat mosses, not shifted by water, have been produced by two, three, or more generations of trees, which have grown successively above one another, at different and distant periods."

I remember many years ago having seen a moss in Aberdeenshire, in all respects resembling that which Dr Walker describes, except that there was no tree growing on the surface. Many similar deposits I doubt not may be found.

A friend recently informed me that he had examined a peat moss in the parish of Rosskeen, in which he observed at the bottom a bed of fir tree roots. Some of them were torn up, as if the trees had been overthrown by the wind, while the greater part remained in their natural position. Their stems appeared as if they had been burnt down to within two or three feet of the ground. The soil on which they had grown was a gravelly loam mingled with peat. Many of the roots were of a large size. Above them there was about three feet of peat, and above that another layer of roots similar to the former. This second layer had also been covered with peat; but the original thickness of this uppermost bed could not be ascertained, in consequence of the neighbouring cottagers having cut away a great part of it for fuel.

The observations which I have now brought forward in reference to the Origin and Nature of Peat, do not enable us definitively to determine what the circumstances are which make some plants in their decay produce peat, while others are transformed into vegetable mould ; but they very clearly show that peat has its origin in the decay of plants that grow on the land, or near the surface of the water, and that it does not originate at the bottom of pools ten to thirty feet deep, and they furnish at least a somewhat more stable foundation for our conclusions than the vague and indistinct statements of M. Boucher de Perthes.

THE GROWTH OR RATE OF INCREASE OF DEPOSITS OF PEAT.

The second object of the inquiry which I proposed, is the rate of the increase that takes place in deposits of peat.

In regard to land formed peat, it needs no argument to show that its increase must be proportioned to the growth of the plants that produce it. Like all other vegetable productions, these plants will grow most luxuriantly in those situations for which they are naturally adapted. If, on the one hand, there be a deficiency of moisture and of shelter, their increase will be slow; but if, on the other hand, in addition to moisture and shelter there be an abundant supply of appropriate nourishment, their vegetation will be luxuriant. In a marsh, for instance, surrounded by a forest, and covered in autumn with the drifting leaves, or in a water-fed meadow, over which the debris of the surrounding fields and woods are spread by the winter's flood, the growth of the marsh loving plants will be vigorous, and the accumulation of peat will be large. Dr Walker says:—

> "It is also to be remarked that the deepest strata of peat are those which are placed nearest the level of the sea; whereas those at a great height are comparatively thin. This naturally results from a more luxuriant vegetation of trees and plants in the one case than in the other."

In reference to *water born* peat, the rate of its increase depends, in the first place, on the growth of the plants that are found in the locality itself, and in the next place, on the nature of the locality. If it is a pool into which streams are collected from a large extent of peat producing country, the deposit will rapidly augment; but in a solitary lake, into which no rivulet flows, the increase will be slow.

It is necessary also that we should advert to the circumstances that either hinder, or altogether prevent the production of peat. The first of these is the cultivation of the land. None of the peat producing plants are cared for by man; whenever, therefore, the soil is brought under the plough, the formation of peat will almost, if not altogether cease. The draining of the land produces a similar effect; when the marsh is laid dry, the indigenous vegetation disappears. Another cause which, in Scotland at least, tends to prevent the vigour of the peat producing plants, is the practice of burning the heath. It is under the shelter of the heath that the mosses and lichens flourish, which are the principal source from which our mountain peat is derived. When that shelter is taken away their size becomes small, and their produce insignificant. At the same time, in consequence of being more exposed to the influence of the weather, a good deal of the previously formed soil will be swept away. We would, in passing, suggest to the proprietors and tenants of our mountain pastures, that it might be well for them to consider, whether by burning the heath they may not ultimately destroy the only vegetation which our mountain ranges can continue to sustain.

Statements by Various Authors.—Having pointed out the circumstances that seem to affect the rate of increase of the deposits of peat, I now turn to the statements of those who may be regarded as authorities on the subject. The question is one of those which must be decided by testimony and observation, rather than by theory and argument.

Sir C. Lyell, in his work on the "Antiquity of Man," gives us the following estimate of the time required for the growth of the peat in the Valley of the Somme:—

> "The antiquary finds near the surface Gallo-Roman remains, and still deeper, Celtic weapons of the stone period. But the depth at which Roman works of art occur varies in different places, and is no sure test of age, because in some parts of the swamps, especially near the river, the peat is often so fluid that heavy substances may sink through it, carried down by their own gravity. In one place, however, M. Boucher de Perthes observed several large flat dishes of Roman pottery, lying in a horizontal position in the peat, the shape of which must have prevented them from sinking through the underlying peat. Allowing about fourteen centuries for the growth of the superincumbent vegetable matter, he calculated that the thickness gained in a hundred years would be no more than three French centimetres. This rate of increase requires so many tens of thousands of years for the formation of the entire thickness of thirty feet, that we must hesitate before adopting it as a chronometric scale. Yet, by multiplying observations of this kind, and bringing one to bear upon and check another, we may eventually succeed in obtaining data for estimating the age of the peaty deposit."

Such are the observations which Sir C. Lyell has adduced as the ground of his belief that "the peat in the Valley of the Somme took thousands of years for its growth."

As M. Boucher's researches do not seem to have been either very accurate or very extensive, I shall give some extracts from other writers, illustrating the growth, or rate of increase, of deposits of peat, and shall begin by copying a few of the many statements taken from continental naturalists by Dr Rennie.

M. de Luc says:—

> "It is customary to dig pits in the mosses at Bremen, about twenty feet long by six feet wide. The first year they are filled with a mucous substance that swims on the water like a green cloud. The second year the substance is composed of fine threads, knit together, and garnished with very small leaves, flowers, and seeds, so that the water is filled with them nearly two feet deep. The third year this is covered with mosses, with creeping roots, leaves, and branches. These cover the water entirely. Thus it becomes a fit soil for aquatic plants, which grow with great luxuriance. The fourth year these plants are so high and thick, that they change the surface on which they grow, and sink with it in the water. The mosses appear again, cover the surface, receive new seeds, and produce a new race of aquatic plants. These sink the surface lower and lower, which is always garnished anew with mosses, and in a few years reach the bottom. The plants at the bottom then decay and die; compressed by the incumbent weight they become consolidated. Those on the surface also decay, and drop in their turn. Thus, little by little, they fill up the whole pit, so that in thirty years the surface is so solid as to nourish heath and other ligneous plants that grow on the adjacent moor."

M. Degner says:—

> "It is a well known fact, that a ditch, ten feet wide by seven feet deep, is often so filled with aquatic plants, that in twenty or thirty years men and cattle may easily pass over it, and that in eighty or a hundred years the whole will be ripened into turf. . . . . When a large pit is dug, the vegetation of aquatic plants is retarded, and the renovation of the moss is checked; whereas in small pits, aquatics rush up with rapidity, and the renovation of the moss is proportionably rapid."

M. Gerard says:—

> "The Valley of the Somme is covered with two feet of soil; below that there are from six to ten feet of moss from Amiens to Pecquigny. Opposite to Etoile it is over thirty feet deep. The lower part of the City of Amiens is built upon a subsoil of moss, twelve feet deep. In some places there is below this a stratum of marl, or a bank of sand and sea-shells."

These extracts give us to understand that it is a well known fact, that, in favourable circumstances, pits six or seven feet deep are so filled with aquatic vegetation, that in less than a century the whole is ripened into turf. The other quotations, adduced by Dr Rennie, lead to a similar conclusion.

These statements have all reference to deposits formed under the surface of the water. I shall now bring forward a few facts, by means of which we may form an estimate of the time required for the accumulation of land formed peat.

Dr Walker says:—

> "There is reason to think that the great extent of Moss Flanders, near Kincardine, owes its origin to an ancient wood, part of the *Silva Caledonia* of Tacitus, which was destroyed by the Romans when they invaded that part of the kingdom. About thirty years ago there was found in this moss, about eight feet below the surface, a large Roman camp-kettle. It is of brass, and so thin as to bend almost like parchment; but is of that sort of brass that is very little injured by rust.
>
> "About the same time a leather bag, containing silver coins of the Heptarchy, and a silver crucifix, was found between two and three feet deep in the Locher Moss. There they had lain probably for about a thousand years, on the boundary between the Saxon and Celtic territories.
>
> "Of late years a Roman ornament of very pure gold was

found in Annan Moss, at the head of Annandale. The place is more than fifteen hundred feet above the sea, and by the side of the Roman road that was made by Julius Agricola. This curious ornament of antiquity was lodged about three feet deep in the stratum of peat, where it probably had remained above sixteen hundred years."

The Earl of Cromarty, in a letter written by him in 1711 to Sir Hans Sloane, says:—

"In the year 1651, when I was nineteen years of age, I accompanied my father on the family estate, in the parish of Lochbroom, in West Ross. I there saw a small plain, covered with a standing wood of fir trees, but so old that they had neither leaves nor bark. Being in the same place about fifteen years afterwards, there was not a tree to be seen. The plain was covered with green moss, by the overthrow of the old trees and the stagnation of moisture descending from the hill. And in the year 1699 I found the whole piece of ground converted into a peat moss, from which the country people dug their peat. . . . . I observed that when they dug down to the gravel, or in places where the waters run off and did not stagnate, the mosses did not grow or revive there again. This led me to direct my tenants not to cut the moss to the gravel, nor in very large openings, but in small pits, that they might grow more hastily. The event answered my expectation. . . . . I have observed that pits which have been dug since *I remember*, have grown up again with new peat, and that, too, sometimes oftener than once, in the same pits."

Dr Macculloch, in his Essay on Peat, in the "Edinburgh Philosophical Journal," vol. xi., p. 53, tells us that the means of promoting the growth of peat is now "so well understood, that it has become a general practice to reserve the superficial covering, and replace it at the bottom, after the peat required for fuel has been removed."

In the first "Statistical Account of Scotland," in the description of the parish of Kincardine, we are told :—

> "The depth of the high moss, or that from which no peat has been cut, is from eight to fourteen feet. . . . . The surface of the clay is everywhere thickly covered with trees, chiefly oak and birch, many of them of a great size. They are found lying in all directions, beside their roots, which still continue firm in the ground in their natural position; and from impressions still visible, it is evident that they have been cut with an axe, or some similar instrument."

In the second "Statistical Account" it is said :—

> "Forest trees are found rooted in the clay beneath the moss, and as numerous as could have grown in the soil. Many are four feet in diameter. The mark of the Roman axe is found on some of these trees. Various Roman antiquities have been found in the clay under the moss."

In the same account mention is made of seventy yards of Roman road found under eight feet of peat moss.

In searching for information in regard to the origin and growth of peat in our different Encyclopædias, the only notice that had any reference to its rate of increase, that I found, was one in the Encyclopædia published by Messrs Chambers, in which we are informed, that "the growth of peat is often rapid; bogs have been known to increase two inches in depth in a year." Here we are told of an instance of increase in one year nearly twice as great as that which M. Boucher supposes to have been produced in a century; but we have no account of the circumstances that induced such rapid growth.

The last quotation I shall make is one that for evident reasons is deserving of special attention :—

"In the moss of Hatfield, as well as in that of Kincardine in Scotland, and several others, Roman roads have been found covered to a depth of eight feet by peat. All the coins, arms, axes, and other utensils, found in British and French mosses are also Roman; so that a considerable portion of the European peat bogs are evidently not more ancient than the days of Julius Cæsar. Nor can any vestiges of the ancient forests described by that general, along the line of the great Roman way in Britain, be discovered except in the ruined trunks of trees in the peat."—"*Principles of Geology*," *by Sir Charles Lyell.*

I have thus brought forward what I conceive to be a sufficiency of facts, for determining the questions that have been started by Sir C. Lyell in reference to the deposits of peat. On the one hand, I have copied the observations of M. Boucher de Perthes, which are the only evidences adduced by Sir Charles in his work on the "Antiquity of Man." On the other hand, I have given a variety of extracts, that show the results to which other inquirers have come. To these many more of a similar import might have been added.

I now lay before the Association the inferences to which I think these various facts naturally lead.

Those who advocate the hypothesis of the great antiquity of man, tell us that the time which has elapsed since the glacial epoch passed away has been one of slow and gradual change. If this supposition had been correct, we must have found in our deposits of peat some evidences of a gradual amelioration of climate since they first began to be formed. We must have found at the bottom trees and plants peculiar to boreal latitudes, of full size, and abundant in number, while, mingled among them, we discovered a few stunted specimens of the vegetation that thrives best in temperate regions. Nearer the surface we would have found the latter class predominating, while the former had either altogether disappeared or become few and insignificant. This, however, is not the case. At the bottom of Hatfield Moss, in Yorkshire, "fir trees have been found ninety feet long, and sold for masts and keels of ships. Oaks have also been discovered there above a hundred feet long. The dimensions of an oak from this moss are given in the 'Philosophical Transactions,' No. 275, which must have been larger than any tree now existing in the British dominions." The trees underlying the peat on the banks of the Forth are the same in species as those that grow in the neighbourhood in the present day, and seem to have been as large in size. In both of these cases the trees appear to have been cut down by the Romans; but a similar remark might be made in reference to the trees at Strathcluony and Rosskeen, where the foot of the Roman invader never trode. We must, therefore, conclude that there has been no change in the climate of Britain since these deposits of peat began.

It is, however, to the inferences which have been drawn from the growth of peat, in regard to the antiquity of the peaty deposits, that attention is specially to be drawn. On the one hand, Dr Walker says:—

> "Peat appears not to be of a more remote date than is consistent with the general opinion of the formation of the present earth. In the present state of the earth and atmosphere, the

stratum of peat must necessarily be formed in certain climates. In these climates it has gradually increased, and must increase, though by a very slow process; yet its general depth, which is very similar in different parts of the globe, proves it to be of very limited era."

In support of this opinion he adduces a great number of interesting facts, some of which I have quoted. I have expressed my own full concurrence with Dr Walker's conclusions, and in corroboration of my views have brought forward a variety of additional observations, to which I might easily have added many more of a similar kind.

On the other hand, M. Boucher de Perthes informs us that peat accumulates so very slowly, that its rate of increase is only three centimetres—that is, an inch and a fifth—in a century; and in support of his conclusion, tells us that he had found several flat dishes of Roman pottery buried under nineteen inches of peat. As to the proof he had of these vessels being Roman, as to the nature of the deposit in which they were discovered, or as to the locality in which the deposit was formed, we have, however, no information. And Sir C. Lyell, in advocating his peculiar views in regard to the antiquity of man, keeps out of view the results to which former inquirers had come, forgets apparently what he himself had written in his "Principles of Geology," and affirming that the peat in the Valley of the Somme "in all likelihood took thousands of years for its growth," adduces the observations of M. Boucher de Perthes as the only evidence on which he rests his conclusions.

Sir Charles, no doubt, tells us that the estimate of M. Boucher de Perthes would require so many tens of thousands of years to account for the entire thickness of the peat in the Valley of the Somme, that we must hesitate before adopting it as a chronometric scale; but he concludes with saying, that "it is by multiplying observations like those," made by M. Boucher de Perthes, "that we are eventually to succeed in obtaining data for estimating the age of the peaty deposit."

I leave it to the Association to determine on which side the weight of evidence and argument is found.

If M. Boucher's chronometric scale be adopted, then, certainly, there is good ground for the counsel which Sir Charles gave to the British Association at Bath, when he told them, "that we must be prepared to extend our ordinarily received ideas in regard to chronology." We must apply the remark to the chronology of the Latin writers as well as to that of the Hebrew penmen, and since a thickness of eight feet of peat, according to the rule which he suggests, indicates a duration of eight thousand years, instead of believing, as we have been accustomed to do, that the Romans invaded Scotland some sixteen hundred years ago, we must bow to the authority of the new chronometric scale, and gather assuredly, from the depth of the deposit by which their works are covered, that it is exactly eight thousand and sixty-seven years since they constructed their fortifications, and made their roads on the banks of the Forth.

CONJECTURE AS TO THE TIME WHEN THE DEPOSITS OF LAND FORMED PEAT IN BRITAIN BEGAN.

When speaking of the different kinds of deposits of peat, I remarked that they might all be arranged under two classes—those formed under the water, or *water born* peat, as Dr Walker has termed them, and those that have been formed on land. The rate of increase in the first class depends on so many different causes, that we cannot assign even an approximately accurate estimate of it. In regard to them, therefore, we do not attempt any calculation as to the probable period of their commencement. The other class, containing the different varieties of land formed peat, exhibit a much greater uniformity of growth, and may, therefore, be regarded as affording sufficient foundation at least for a conjecture.

Dr Walker says :—

> "There is a similarity in the depth of extensive peat mosses, in different countries, that deserves attention. In every northern country there are some places where water born peat is lodged to a great depth. But this is to be distinguished from the natural and regular stratum of peat that is formed in the country. Such deep masses of peat earth may be seen in many parts of Scotland. But it is not from these that the general depth of the peat stratum is to be taken."
>
> "In all the countries where peat is formed, the extensive fields of peat originated from the destruction of ancient woods, seem to run from eight to eighteen feet in depth. The greatest depth of our largest peat mosses in Scotland may in general be estimated at about twelve feet. In Ireland its greatest depth

is said to be twenty feet. This may in part be owing to water born peat with which the deepest ditches and drains in that country are soon filled up. Yet it is reasonable to suppose that the natural peat stratum in Ireland is in general deeper than it is with us, from a greater mildness of climate and greater luxuriance in vegetation. The peat stratum in Holland, which contains trees, is from eight to sixteen feet."

It is in accordance with the acknowledged rules of philosophical induction, that the rate of increase in the deposits, whose origin we can trace, should be taken as a measure by which we are to estimate the age of those whose commencement is unknown. The deposits at Hatfield and Kincardine may therefore be taken as types of the beds which are found in other parts of Britain. In these two cases the increase has been at the rate of six inches in the century. If we assume this as our standard, a thickness of twelve feet indicates a growth of two thousand four hundred years. We thus are led to conclude that the deposits of land formed peat began some five or six hundred years before the birth of our Saviour. As for the deposits of *water born* peat, they are sometimes found underlying the beds that have been produced by the destruction of ancient woods, and from that, and some other circumstances, I am inclined to believe that an earlier origin must be assigned to them.

This recent origin of the land formed peat, unless we adopt the idea that the plants which produce it were then for the first time introduced, a supposition which I presume few are prepared to admit, seems to indicate, that previous to the date referred to the climate of Britain had been so unfavourable to their growth that the deposits they formed were small and insignificant, but that after that time their growth became luxuriant, and the peat produced by them was proportionably increased.

As all seem to agree that warmth and moisture are the circumstances most favourable for the vigour of the plants by which our mosses are formed, it seems natural to conclude, that some time between two and three thousand years ago the climate of Britain underwent a remarkable change, so that a region which had previously been cold and dry became moist and comparatively warm.

This supposition I adduce simply as a conjecture. It seems to be the only hypothesis by which some of the facts I have collected can be satisfactorily explained. It is, however, only hazarded as a conjecture, and has no direct bearing on the subject of the "Antiquity of Man."

ON THE

ELEVATION OF THE SCOTTISH COASTS.

THOSE who adopt the opinion which was expressed by Sir William Armstrong at the meeting of the British Association at Newcastle, and like him maintain, that "the human race has existed on the earth for a period far exceeding the limit of the historical record," refer as one of their evidences to the length of time that must be supposed to have elapsed during the elevation of those deposits in which we find the relics of human art intermingled with shells and other marine remains.

HYPOTHESIS OF A SLOW AND CONTINUOUS ELEVATION.

At present, I propose to direct attention more especially to the deposits that are found on the coasts of Scotland, and shall examine the theory that has been adduced, in regard to their origin and elevation, by Sir C. Lyell, who is the principal exponent of the views of those who maintain the great antiquity of man. His statement is as follows:—

"It has long been a fact familiar to geologists, that, both on the east and west coasts of the central parts of Scotland there are lines of raised beaches, containing marine shells of the same species as those now inhabiting the neighbouring sea. The two most marked of these littoral deposits occur at heights of about forty and twenty-five feet above high-water mark. . . . .

"The twenty-five feet rise is only the last stage of a long antecedent process of elevation; for examples of recent marine shells have been observed forty feet and upwards above the sea in Argyleshire. At one of these localities a rude ornament of cannel coal has been found, fifty feet above the sea level, covered with gravel containing marine shells. . . . .

"There seems strong presumption in favour of the opinion that the date of the (twenty-five feet) elevation may have been subsequent to the Roman occupation. . . . . If we suppose the upward movement to have been uniform in central Scotland, before and after the Roman era, and assume that as twenty-five feet indicates seventeen centuries, so fifty feet imply a lapse of twice that number, or three thousand four hundred years, we should then carry back the date of the ornament in question to fifteen centuries before our era, or to the period usually assigned to the exodus of the Israelites from Egypt."—"*Antiquity of Man*," pp. 47, 48.

Here we have first "a supposition" that there has been a uniform upward movement, and then "a strong presumption" that the date of the twenty-five feet elevation may have been subsequent to the Roman occupation. This *supposition* and *presumption* I propose in the first place to examine, and shall then adduce some facts which show that there has been no change of relative level of the coasts of Scotland since the time of the Roman invasion. I shall afterwards endeavour to prove that the elevation which did take place some time previous to that event was a sudden one.

Supposition of a Uniform Upward Movement.—The argument in support of this supposition is thus stated:—

> "The upward movement now in progress in parts of Norway and Sweden, extends throughout an area of a thousand miles north and south, the amount of elevation always increasing as we proceed towards the North Cape, where it is said to equal five feet in a century. If we could assume that there had been an average rise of two and a-half feet in each hundred years for the last fifty centuries, this would give an elevation of one hundred and twenty-five feet in that period. A mean rate of continuous vertical elevation of two and a-half feet in a century would, I conceive, be a high average."

To this rule for estimating the time required for the upheaval of the coasts of Europe Sir Charles repeatedly refers. The most elaborate application of it we find when he is speaking of the coasts of Sardinia.

> "Count Albert de la Marmora, in his description of the geology of Sardinia, has shown that, on the southern coast of that island, at Cagliari and in the neighbourhood, an ancient bed of the sea, containing marine shells of living species, and numerous fragments of antique pottery, has been elevated from seventy to ninety-eight metres above the present level of the Mediterranean. If we assume the average rate of upheaval to have been as before hinted, two and a-half feet in a century, three hundred feet would give an antiquity of twelve thousand years to the Cagliari pottery, even if we confine our estimate to the upheaval above the sea level, without allowing for the original depth of water in which the mollusca lived."

This argument is singularly inconclusive. In the *first* place—while we are told of the slow and gradual rise of the land in Sweden, no notice is taken of the many instances of sudden change of level that have taken place in other parts of the world. If we confine our attention to his work on the "Antiquity of Man," the language which Sir Charles employs would lead us to believe that slow continuous change universally prevails. When we read his former publications, we find so many examples given of sudden rise and of sudden depression, that we are rather led to conclude that sudden change is the rule, and continuous movement the exception. In the *next* place—it is assumed that examples of change effected by subterranean agencies in one country are to be employed as our rule in estimating the result of their operations in another. Having adduced the fact that there is a continuous rise of two and a-half feet in a century in Scandinavia, we are given to understand that therefore it must have taken twelve thousand years to raise the coasts of Sardinia. It needs no argument to show the fallacy of such a supposition. It would have been much more natural if he had referred to the fact, that the coast of Puzzuoli, near Naples, in the year 1538, was raised twenty feet in a single night, and drawn as an inference from that example of the effects of subterranean agency, that therefore it must have taken seven days and a-half to elevate Cagliari.

I have stated the whole argument adduced in support of the "supposition of a continuous rise," and I think that it needs no proof to show that whatever the action of subterranean forces may have been in any other part of the globe, that that affords no ground for concluding that a similar action has prevailed in Britain.

Presumption of a Twenty-five Feet Elevation subsequent to the Roman Occupation.—I quote, as before, from the "Antiquity of Man."

> "Recent explorations by Mr Geikie and Dr Young, of the sites of old Roman harbours along the southern margin of the Firth of Forth, lead to similar inferences. Inveresk is the site of an ancient Roman port, and if we suppose the sea to have washed the foot of the heights on which the town stood, the tide would have ascended far up the Valley of the Esk, and would have made the mouth of that river a safe and commodious harbour; whereas, had it been a shoaling estuary, as at present, it is difficult to see how the Romans should have made choice of it as a port."
>
> "At Cramond was Alaterva, the chief Roman harbour on the south-west of the Forth, where numerous coins, urns, and sculptured stones, and the remnant of a harbour, have been detected. The old Roman quays built along what must have been the sea margin, have been found on what is now dry ground, with a dreary expanse of mud extending outward well nigh two miles. Had these shoals existed eighteen centuries ago, they would have prevented the Romans from making this a port; whereas, if the land were now to sink twenty feet, Cramond would unquestionably be the best natural harbour along the whole south side of the Forth."

These are the grounds on which Sir Charles has formed his "strong presumption" in favour of the opinion that the date of the elevation may have been subsequent to the Roman occupation.

In regard to these observations it is sufficient to say, that even though I had been fully satisfied with the care and accuracy of Mr Geikie's observations, which is very far from being the case, they go no further than to prove that some of the bays in the Firth of Forth have in recent times been silted up, in consequence of gravel being brought down by floods in the rivers, and of sand and mud being carried inwards by the shifting currents of the sea. Mr Geikie does not attempt to show that the land has been raised. He speaks of the remains of the Roman harbours being now found with a dreary expanse of mud between them and the sea; but he does not prove that these remains are now twenty or twenty-five feet higher above the sea level than they were when originally built by the Romans. The filling up of the bays at Cramond and Inveresk, is no more a proof that the general level of Scotland has in recent times been raised, than the washing away of the high bank between Leith and Newhaven is a proof that it has been depressed.

With all the respect that is due to the position which Sir C. Lyell holds in the scientific world, I must regard his arguments in favour of a continuous rise of the coasts of Scotland as altogether unsupported by facts; and, as I believe that the coasts of Sweden are rising, because there is unquestionable evidence that such is the case; for example, rocks that were formerly known to be covered with the water are now seen to be several feet above it; so, in like manner, I am persuaded that there has been no recent rise of the Scottish shores, because there is no evidence whatever of any change of sea level on our coasts within the memory of man, or the record of history.

In opposition to the inferences which Sir Charles draws from Mr Geikie's observations, I shall now adduce some facts, which seem very distinctly to prove that there has been no elevation of the British coasts since the days of the Romans.

Facts relating to the Elevation of the Scottish Coasts.—These are from a variety of sources.

The Rev. Mr Nimmo, minister at Bothkennar, in his "General History of Stirlingshire," published in 1787, thus describes the Roman road near Stirling:—

> "After the road, known by the name of the Camelon Causeway, hath reached the town of Stirling, in the environs of which every vestige of it is entirely lost, amidst houses, enclosures, and cultivated fields, it takes a direction westward to a ford called the Drip, near Craigforth. Half a mile westward of the Castle, and not far from a place called Kildean, very plain traces of it are discernible. The peculiar form and regular dimensions, together with the straight course, easily distinguish it from other causeways. Nearer to the Drip, too, its foundations have been lately digged up. The ford hath a firm and solid bottom, and during the summer season little above two feet of water. There was no occasion for a bridge to transport the hardy sons of Rome, whom much more stately rivers did not intimidate from their darling project of subduing and plundering the world."

The accounts of the Roman roads around Stirling, which are given by the various writers in the "Statistical Account of Scotland," all lead to the conclusion that no change of level has taken place since the Imperial legionaries were stationed there. If the ground in that district had been sunk twenty-five, or even ten feet, below its present level, the Roman roads and the Roman fords would have been utterly useless.

A friend in Stirling, who has paid particular attention to the antiquities connected with that part of the country, has informed me that the Roman roads in that neighbourhood not only bear marks of having been constructed at a time when the comparative level of sea and land was the same as it is at present, but that these roads all lead to those places where alone fords could now be made. The valley through which the river flows, is in general filled with a bed of clayey loam, but in some places it is crossed by ridges of stones and gravel, which have suggested to some geologists the idea of ancient moraines, and it was along the top of these ridges that the Romans formed their fords.

Mr Smith of Jordan Hill, in "Edinburgh Philosophical Journal," says:—

> "The change of level must have taken place anterior to the invasion of the Romans. Diodorus Siculus, who wrote during the reign of Augustus, describes St Michael's Mount in Cornwall as an island connected with the mainland by a space covered every tide, but dry at low-water; a description which would apply accurately at the present day. In Scotland, the Roman wall, which crosses the island from sea to sea, has evidently been formed at both ends with reference to the present level."

Mr Bald, in describing the skeleton of the whale found at Airthrie, says:—

> "To the eastward of the place where it was found are the remains of a Roman causeway. The traces of the causeway were, some years ago, distinctly seen. It led to the Manor ford. Here was a castellum which is now destroyed, but which was in good preservation within the last forty years. It appears, therefore, that since the time of the Roman invasion very little change has taken place, either upon the bed of the Forth at the

place, or upon the level of the adjacent banks."—*Edinburgh Philosophical Journal*, vol. i., 1819.

Dr Rennie, in his Essay on Peat, says:—

> "The level of the sea is the same in Lincolnshire, and on the opposite shores of the Continent, as in Cæsar's time. The coast is still, in every respect, similar to what he describes it. The Roman ways still exist, and reach and terminate at the very spot which he points out."

The arguments which I have brought forward, and the quotations which I have adduced, are, I presume, sufficient to show that the "supposition" of a uniform upward movement in Scotland is altogether destitute of probability, and that the "strong presumption" of a twenty-five feet rise, subsequent to the Roman occupation, is not only unsupported by satisfactory evidence, but is distinctly contradicted by facts.

After adducing the hypothetical calculations which we have been examining, Sir Charles says:—

> "All such estimates must be considered, in the present state of science, conjectural, since the rate of movement of the land may not have been uniform, and its direction not always upwards, and there may have been long stationary periods, one of which, of more than usual duration, seems indicated by the forty feet raised beach, which has been traced for vast distances along the western coast of Scotland."

He is necessitated to allow that his estimates are tentative and conjectural; but he never seems to imagine that the elevation of the Scottish coasts may have been sudden, and consequently, that he may be altogether mistaken in supposing that that elevation affords any support to his hypothesis in regard to the antiquity of man. On the contrary, his words rather imply that the age of the human family may not improbably be found to exceed even the estimate which he has formed.

EVIDENCES OF A SUDDEN UPHEAVAL OF THE SCOTTISH COASTS.

I have now replied to the first part of Sir Charles' statement, in which he adduces his reasons for concluding that there has been a rise of twenty-five feet since the time of the Roman occupation. I have been careful and minute in my reply, because the high estimation in which he is held among scientific men entitles him to such regard.

For the second part of his hypothesis, that the elevation of the Scottish coasts was slow and gradual, he adduces no evidence excepting the continuous rise of the land in Sweden, which has already been considered. I therefore proceed at once to disprove his suppositions, by directing attention to some facts which show that the last elevation of the Scottish coasts was sudden.

Deposits of Clay and Loam found in the Valley of the Forth.—The Carse of Stirling, or deposit of alluvial soil which occupies the middle part of the Valley of the Forth, when seen from the top of one of the neighbouring hills, presents the appearance of a long level plain, through which the Forth, with many strange twistings and turnings, slowly winds its way. Its length is upwards of thirty miles. Its breadth, below Stirling, is about five.

On closer inspection it is found to be diversified with elevations and depressions. The banks near the river vary from ten to twenty feet above ordinary high-water mark, and the surface at the outer edge of the carse, near the rising ground on either side, is from twenty-five to thirty feet above that height. There is thus a fall of from ten to twenty feet between the river and the outer boundary of the deposit.

The whole surface is one continuous bed of loam. There is a diversity of colour. In some places it is of a bluish gray, in others it is of a red or yellowish hue. There is a diversity also as to its composition, and the farmer finds some portions of it more fertile than others. But the whole is continuous—that is, there is no sudden transition, the one colour shades away into the other. There is no sign of lamination, no trace of tidal action, no superficial beds of sand or comminuted shells. There is no stone, nor pebble, nor shell, excepting such as have been brought there by the hand of man.

A correspondent of the Wernerian Society (*Memoirs*, v. 425), thus describes the Valley of the Forth:—

> "Above Stirling, the clay of this district, presenting a uniformity of surface, is of varied quality. So far as exhibited by a few deeper operations, its depth does not exceed twenty feet. Stones and gravel of any description are unknown through its whole extent. These remarks apply equally to the lower district. But though the carse clay soil presents in both the appearance of an extensive plain, it is perhaps nowhere horizontal. It contains depressions, elevations, and inclined planes."

The deposit of clay, excepting near the outer edge, where, of course, it is much thinner, is from ten to twenty feet in thickness. The upper part is generally of a lighter hue, the colour becoming darker as we descend. This upper part, at the same time, is more adhesive, and forms a finer clay, of which the brick-maker makes pipes and tiles, while the part beneath can be made only into bricks.

The substratum on which the carse clay rests is very various. Sometimes it is a dark blue clay, twenty, thirty, or even eighty feet deep. Sometimes there are beds of shells similar to those now found in the frith below. In the part above Stirling, "it reposes on small gravel, sand, red till, and tilly earth, which rests on the old red sandstone." In other places we find beneath it a mass of silt, which, when wetted, becomes a soft and yielding mud. Not unfrequently there are under it layers of peat. This peat appears to be all *water born*, as Dr Walker would have termed it. In the "Statistical Account of the Parish of Stirling," it is described as "a stratum of vegetable matter." In the description of the skeleton of a whale found at Menteith ("Memoirs of Wernerian Society," v. 440,) it is said, "Under the clay there is a stratum of black spongy peat earth. Its colour is nut brown, changing into deep black within five minutes after exposure. The peat is here six feet deep. It contains remains of wood, particularly of alder, and of various water plants, and is impenetrated vertically by the roots of the *equisetum.*"

This account of the carse clay deposit contains all the facts that seem necessary for our present investigation, and, having used my utmost endeavour to ascertain accurately the truth, I think it may be received as worthy of confidence.

Those who look to the elevation of the Scottish coasts as a kind of "chronometric scale," by which we may estimate the antiquity of man, tell us that that elevation has resulted from a slow continuous rise of the land. With this hypothesis the appearances exhibited by the deposit we have been describing do not at all correspond.

In the first place, it seems very evident that, when the deposit was formed, the whole must have been in a fluid state. It must, in short, have been a mass of thin mud. On this supposition only can we account for the finer and more tenacious clay, formed, we may suppose, of the finer particles of the floating mass, being uniformly found at the surface, while the coarser and less tenacious portion is below. On this supposition alone can we account for the entire absence of stones, gravel, and shells, and for the want of any abrupt division between the constituent parts of the deposit.

The most probable supposition is that the bottom of the frith was covered with beds of loam of different kinds, brought down by the rivers that meet in the neighbourhood of Stirling, and that these beds were loosened and diffused through the water by some commotion of the sea, such as those by which earthquakes and volcanic eruptions are so generally accompanied.

In the next place, we remark that the mud thus stirred up must have been raised by the sudden action of subterranean forces. Had it been allowed to subside without any immediately subsequent upheaval, it would have formed a bed at the bottom of the frith. Some parts of it would have been always covered with the water, while others were left dry when the tide retired. The consequence of this would have been that we would now have found on its surface various traces of tidal action, with beds of sand and shells, some of the shells lying in their natural position as when the animal was alive, others broken and in disorder, as if left by a storm. Since these beds are entirely absent, and we find no trace of tidal action, we conclude that the tempest of the deep which disturbed the long accumulated deposits and filled the estuary with a mass of mud, was immediately followed by the action of a subterranean power which elevated at once the bed of the estuary and the adjoining shores.

Deposits of Shells in the neighbourhood of Stirling.—In almost all the descriptions given in the Statistical Account of the parishes around Stirling, we find mention made of beds of shells beneath the carse clay. In the account of Gargunnock, we are told, "Below the blue clay a bed of sea-shells is deposited, about ten feet from the surface. The bed is said to be found everywhere in the Strath of Menteith, which is twenty miles long, and in some places between three and four miles broad." In the account of Logie, we read, "The upper part of the deposit is a strong adhesive clay, from three to six feet in thickness, under which is a very soft silt, or slush, of a dark bluish black colour. In the silt is uniformly found a bed of shells mixed with sand. This bed of shells extends for miles both to the east and west of Abbey Craig." In the account of St Ninians, it is said, "Vast quantities of marine shells are scattered in beds over the whole of this portion of the parish." Similar descriptions are given in other parts of the volume; but none of them is very minute; and none of the writers seem to have thought it necessary to say whether the shells remained in the position they occupied while the fish was alive, or whether they were gathered together in confusion, like those we find on the sea-shore after a storm. My own inquiries have led me to conclude that, in the majority of cases, the shells remain in their natural and original position.

Being anxious to ascertain the nature of these deposits more minutely, I paid a visit to Stirling, and was directed by a friend to a deep cutting that had been made for agricultural purposes, in the parish of Logie. The following are the notes I took down:—

On the farm of Black Grange, occupied by Mr William Thomson, a large drain has been cut. It terminates in the Forth, the bottom of the drain being on a level with low-water mark. At the bottom of the cutting there are two feet of dark blue loam, above which there is a different variety of loam of a lighter colour, and which has in some places a reddish hue. This upper loam is from ten to fourteen feet in thickness, the surface being irregular in height. In cutting the drain—the bottom of which rises as it recedes from the river, in order to give the declivity necessary for carrying off the water,—for about half a mile from the river no animal remains were found, excepting the bones of a large fish, which a naturalist to whom they had been shown pronounced to be those of a sword-fish. They were found about thirteen feet from the surface. Many fragments of decayed wood were picked up. About half a mile from the river, beds of sand were found lying between the dark blue loam and the lighter loam that covered it. These beds varied in thickness from one foot to three feet and a-half, and contained a large quantity of shells of the common mussel and cockle. These shells were generally intermixed, though sometimes the one variety was more abundant, and sometimes the other. The shells, in general, were entire, and occupied the same position in the sand which they ordinarily do when the animal is alive. Among these shells some oysters were found. In one place there was a bed of them. The oyster shells were very large and thick. Some shells of the *scrobicularia piperata* and *solen* were also picked up.

The sand in which the shells were found was of a very dark colour. The farmer and his labourers both spoke of it as "the black sand." In one place, where there was a considerable influx of water into the drain, there was "a most abominable smell," and the whole bed had an unsavoury odour. Mr Thomson mixed some of the sand and shells with other materials in a compost heap, and found it effective as a manure.

The facts which have now been stated lead to some interesting inferences.

These beds must have been raised by the action of subterranean agencies. Irregular masses of shells may be thrown up many feet above their original level by the force of the "storm wave;" but beds of sand, with shells entire and in their natural position, could only have been elevated by a force which at the same time raised the adjoining coast.

These beds must have been covered over with the superincumbent mud, which is now consolidated into loam, while still remaining in their original position under the water. The sand had not been disturbed, and the mollusca seem to have been alive, when the whole was buried beneath a deposit of from ten to fourteen feet in thickness. By this means the sand-beds were hermetically sealed up, if we may so express ourselves, and the animal matter of the mollusca was prevented from passing off in gaseous combinations into the water and air. It consequently imparted to the surrounding sand its dark colour, its fertilizing properties as a manure, and its "abominable smell;" in the same manner that the contents of our common sewers impart similar properties to the rubbish and mud that are found at their bottom. Protected, we may also add, in a great measure from the action of the atmosphere, the shells, though very brittle, do not seem, when first dug up, to have been so friable as those which are found in other ancient deposits where aerial influence has been only partially excluded. If these beds had not been suddenly enveloped in their almost impermeable covering, all trace of animal odour must long ago have passed away, and the shells would have exhibited more striking evidences of decay.

These beds cannot have been raised by a slow continuous elevation. In the Firth of Forth oysters are generally found from four to six fathoms under water. In one instance, but in one only, they are found so near ordinary low-water mark, that at spring-tides they are laid bare. The bed of oysters at Black Grange, therefore, we presume, must have been formed at least fifteen feet below high-water mark; and if no subsequent upheaval had raised them above their original level, the layer of clay that covers them must have been overflowed at high-water, and exposed at spring-tides and in storms to the tidal action which "shoaling estuaries" experience. Since there is no evidence of any such influence of the tide, and no superficial bed of sand or shells, we conclude that the formation of the clayey deposit must have been immediately followed by an upheaval of the coast which raised it at once above the action of the waves.

Skeletons of Whales discovered near Stirling.—Several of these skeletons, some of them remarkably entire, have been dug up in the neighbourhood of Stirling. They have been found at different times, and at different places. I shall give a brief enumeration of these discoveries, and note down the circumstances connected with them that seem most important.

Skeleton at Airthrie.—In draining some ground adjoining the gate to Airthrie Castle, the workmen found the skeleton of a whale, and the proprietor, Sir R. Abercrombie, gave instructions that all the bones should be carefully collected.

"The skeleton is about seventy-two feet in length. The bones were generally found at the depth of four and a-half feet, but some of them were nearer the surface. Almost all the bones of the animal were found, and were in good preservation, excepting the jaw-bones, which were immured in a dry bank, and upon exposure to the air the cellular structure speedily fell to powder. The other bones of equally open structure which lay in clay or sludge, remain entire. Close by the skeleton two pieces of stag's horn were found, through one of which a hole appears to have been perforated, of about an inch in diameter. The bones are in the Edinburgh Museum."—*Mr Bald, in the Edinburgh Phil. Journal*, vol. i., 1819.

In an account of this skeleton, communicated by Mr Bald to the "Statistical Account of the Parish of Logie," in 1841, in which he makes some slight alterations on his former description, he says:—

"The bones are in general hard and undecayed, and lay in regular connected order from the head to the tail. They were embedded in the blue silt, immediately under the stiff clay. It was found, from very accurate levels, that the skeleton lay twenty-two feet higher than the pitch of the highest stream-tides of the River Forth immediately opposite; from which circumstance there is reason to conclude, that the highest tides of the River Forth are, in this district at least, twenty-six feet lower than they were at the time when the whale was stranded."

Whale at Menteith.—

"In October 1824, about three-quarters of a mile from the parish church of Kincardine, and nearly a mile from the present course of the Forth, some bones of a whale were found, consisting principally of a large portion of the cranium, a scapula, and several vertebræ in a mutilated state. The bones were found in what is called carse clay, which at this place is only four feet deep, as it is within four hundred yards of the outer edge of the carse lands where the clay approaches the surrounding banks. The bones lay at the bottom of the clay bed, but did not penetrate at all into the bed below. Under the clay there is a stratum of black spongy peat earth. The peat here is six feet deep. It contains remains of wood, particularly of alder and of various water plants, and is penetrated vertically by the roots of the *equisetum*. It rests on sand, with little or no admixture of clay."—*H. H. Drummond, Esq., Mem. Wernerian Society*, v. 440.

Skeleton at Dunmore Park.—The Earl of Dunmore says:—

"The whole remains lie about half a mile or three-quarters of a mile from the present bed of the river. It is covered by three or four feet of alluvial soil, and is rather more than twenty feet above the ordinary spring-tides. Its length is about seventy or seventy-five feet."—*Edinburgh Phil. Journal*, 1824.

Another account, in the following number, by Mr Reddoch, speaks of some of the bones as having been found at the depth of only two feet, and estimates the length of the skeleton at from eighty-five to ninety feet. He says:—

"By measurement it has been ascertained that the place where the remains lie is between twenty-three and twenty-four feet higher than the highest tide of the Forth at present. The soil in which they occur is a stiff clay, which has been found near the spot to a depth of twenty-seven feet, resting on freestone. There seems but little doubt that this animal was stranded where it now lies about the same period as the whale at Airthrie, and that a number of them must have been stranded in coming up the Forth at the same time."

Whales at Stirling.—More recently other two skeletons have been found in the brickfields beside Stirling.

These skeletons have all been found in the carse clay, generally in the lower portion of it. Except the deer's horns found at Airthrie, which seem in some way or other to have become entangled with the remains of the whale, and carried along with it, these skeletons, and the bones of the sword-fish at Black Grange, are the only animal remains found in that deposit. The circumstances in which they were found, lead to conclusions very similar to those which we deduced from the conditions of the shell deposit.

They must have been entire, or only partially decayed, when they were swept along by the current of mud that carried them to the places where they were found. If they had been cast ashore, and left on the beach exposed to the influence of the atmosphere and the action of the waves, these skeletons would very soon have been separated into pieces, and the bones would have been scattered and broken. The circumstance of their having been found so entire as they are, can only be explained on the supposition that they were covered with the superincumbent mud while the skin and ligaments that bound them together were still undecayed. They must also have been raised at once above the influence of the tide. If in the process of elevation they had been exposed to the action of the wave, the covering of mud must have been washed away, the skeletons exposed to the weather, and the bones would have been weather-beaten, scattered, and broken. The elevation of the coast must therefore have been sudden.

Ancient Boats Dug up in the Valley of the Clyde.—Mr Smith of Jordan Hill, in "Edinburgh Philosophical Journal," vol. xxv. 390, says:—

> "We have traces of changes of level on every side of the British Island. It is quite evident that some of these changes must have been sudden, and that beds of testaceous animals have been entombed alive by the subsequent deposit of clay or sand to a considerable depth. This is particularly observable in the laminated clay in which marine remains are so frequently found in the basin of the Clyde. The upper parts seem quite destitute of them, and it is only when the excavations are made deep enough, as in digging wells, or coal-pits, or in the lower beds of brickworks, that they may be expected to be found. In the brickworks near Glasgow, I am often told by the workmen that they are not deep enough for shells."

The bed of loam in the Valley of the Clyde very closely resembles that which is found in the neighbourhood of Stirling. It is particularly interesting to the geologist, in consequence of the number of ancient boats that have been found in it. The position of some of these boats is thus described by Mr Chambers:—

> "The situation of the boats found under the Tontine and Tradeslands, is twenty-one or twenty-two feet above high-water in the river. The deposit immediately underlying the Trongate and London Street is a bed of sand. This rests on laminated clays, the same as occur at Annfield and on the other side of the river. These clays abound in several places in recent marine shells. They are deposited on the boulder till. The laminated sands do not appear such a deposit as a river flood

would bring to the spot, even if it could reach it. It therefore appears that we scarcely have an alternative to the supposition that when these vessels foundered, and were deposited where, in modern times, they have been found, the Firth of Clyde at Glasgow was a sea, several miles wide, covering the site of the lower districts of the city."—*Sea Margins*, p. 208.

Sir C. Lyell gives us some farther particulars :—

"Mr Buchanan, writing in 1855, informs us, that in the course of the eighty years preceding that date, no less than seventeen canoes had been dug out of the estuarine silt. Five of them lay buried under the streets of Glasgow. Twelve others were found about a hundred yards back from the river, at an average depth of about nineteen feet from the level of the soil: but a few of them were only four or five feet deep, and consequently more than twenty feet above sea level. Nearly all of these ancient boats were formed out of a single oak stem, hollowed out by blunt tools; a few were cut beautifully smooth, evidently with metallic tools. Two of them were built of planks, one of which, dug up on the property of Bankton, was eighteen feet in length, and very elaborately constructed. Its prow was not unlike the beak of an antique galley; its stern, formed of a triangular shaped piece of oak, fitted in exactly, like those of our own day. The planks were fastened to the ribs, partly by singularly shaped oaken pins, and partly by what must have been square nails of some kind of metal. These had entirely disappeared; but some of the oaken pins remained. In one of the canoes a beautifully polished celt, or axe, of greenstone, was found; in the bottom of another, a plug of cork."

I reason in regard to these ancient vessels as I did in regard to the skeletons found in the neighbourhood of Stirling, and come to similar conclusions.

It is a well known fact, that if a stake be driven down into the bottom of a lake, so that while one part of it is embedded in the mud, another is in the water, and a third is exposed to the air, in a very short time the top begins to decay, and will soon be broken off; the portion in the water, corroded, if we may use the expression, by the air diffused through the water, does not long remain entire; while that which is deeply embedded in mud undergoes for a long time but very little change.

The state of preservation in which these vessels were found shows that they could not have been long exposed to the destroying influences which are found both in water and in air. Not long after their submergence they must have been protected from decomposition by a covering of mud closely enveloping them.

In like manner, we argue that their elevation must have been sudden. If they had been raised from their original position by a slow and continuous process, whenever they were brought to a level with the water they would have been exposed to the action of the waves, the coating of mud must have been washed away, and left them to the influence of the atmosphere. We cannot tell how long they may have remained embedded in mud; but had they been left without that protecting covering, either under the water or above it, they must in no long time have wholly rotted away.

The elevation, therefore, must have been sudden.

I have now completed the task which I set before me when I proposed to examine the arguments which those who maintain the great antiquity of man have endeavoured to draw from the discoveries that have been made in the littoral deposits of Scotland. In the first part of my Paper I have proved, as I believe, that the supposition of a gradual rise having taken place since the Roman occupation is not only destitute of evidence, but is directly contradicted by facts. In the second part of it, I have brought forward what I conceive to be evidence sufficient for concluding that some time previous to the Roman invasion there was an elevation of the Scottish coasts, and that the elevation which then took place was sudden.

With all the respect, therefore, that is due to Presidents of the British Association, and to men of world-wide reputation, I am bold enough to affirm, that there is no evidence to be found in the littoral deposits of Scotland to justify the belief, that the human race has existed on the earth for a period far exceeding the limit of the historical record, and that the finding of a cannel coal ornament in a bed of sand and shells, fifty feet above the level of the sea, is not sufficient to support the conclusion of Sir C. Lyell, that Scotland was inhabited fifteen centuries before the Christian Era.

INFERENCES THAT MAY BE DRAWN FROM THE PRECEDING INVESTIGATIONS.

While my primary object in entering into this inquiry was to ascertain the weight that is due to the arguments of Sir C. Lyell in regard to the antiquity of man, I have found the subject interesting in itself;

and it has led to some inferences and hypotheses, more or less probable, which may not be altogether unworthy of the consideration of geologists. They form no part of my argument, but they are connected with it, and may serve to throw some light upon it.

Extent of Rise at the Last Elevation of the Scottish Coasts.—Mr Bald, in his account of the Airthrie whale, tells us, that the skeleton lay "twenty-two feet higher than the pitch of the highest stream-tides of the river immediately opposite." He also tells us that the bones, in general, lay about four and a-half feet under the surface. His measurement, therefore, shows that the surface of the carse clay at Airthrie is twenty-six feet above high-water mark at stream-tides. The Earl of Dunmore says, that the whale found in Dunmore Park was covered by three or four feet of alluvial soil; and we are afterwards informed that the place where the remains lie is between twenty-three and twenty-four feet higher than the highest tide of the Forth at present. In the "Statistical Account of the Parish of Alloa," we are told that the carse clay, at the line of junction with the old alluvial cover, is about twenty-five feet higher than the surface of the river at the highest spring-tides.

It is rather unfortunate that the standard adopted in these accounts is "the pitch of the highest stream-tides." I found, on inquiry, that the rise of the water at spring-tide is very varied. It is sometimes ten or even fourteen feet above ordinary high-water mark. I have been led to believe, however, that, in general, it may be estimated at about five feet. This would lead us to reckon the height of the carse clay at the highest parts—that is, at those places which are farthest from the river—at about thirty feet above ordinary high-water mark. On the banks of the river it is ten feet; sometimes it is even less.

I have already directed attention to several peculiarities of this deposit, which show, that previous to its elevation it must have been in a kind of fluid state. While it was still in that condition, a mass of floating mud, it covered the bottom of the estuary. Now, when it has been consolidated into clay, we can tell its height above ordinary high-water mark. I find it, however, very difficult to determine the height at which it stood previous to the elevation.

If we suppose the surface of the muddy mass to have been from five to ten feet below high-water mark at the time when the upheaval took place, this would make the total rise of the Scottish coasts to have been from thirty-five to forty feet. Thirty feet, at least, it must have been; but how much more, as yet, I can only conjecture.

Deposits of Twenty-five and Forty Feet above High-water Mark.—Geologists tell us that "the two most marked of the littoral deposits occur at heights of about forty and twenty-five feet above high-water mark." The Carse of Stirling belongs to the first of these classes. As we have already remarked, before its elevation the clay that now forms its surface covered the bottom of an estuary. In like manner, we may suppose that a great many of the beds or terraces, which we find from ten to twenty-five feet above high-water mark, were originally formed by the action of the tide at the low-water level of a former time, or a little beneath it.

The deposits of forty or fifty feet above ordinary high-water mark, which Mr Smith of Jordan Hill speaks of as forming a marked feature of the western coast of Scotland, correspond exactly in elevation with the high-water terraces, which must have been formed when the level of the land was thirty to forty feet lower than it is at present. Such terraces, or "storm wave beaches," we find at present in the course of formation on all parts of our coasts. They vary in height from five to fifteen feet above ordinary high-water mark. A similar process we must suppose to have been going on in the period that preceded the upheaval of the Scottish coasts.

Area of the Elevation.—The twenty-five and forty feet terraces are found not only on the coasts of Scotland, but also, if I read the statements of geologists aright, on the coasts of England and the northern parts of France. This seems to indicate that the whole of the western coast of Europe was at that time raised from thirty to forty feet above its former level.

Temperature of the Ocean on the Coasts of Scotland Previous to the Last Elevation of the Land.—This is a subject into which, as yet, very little inquiry has been made, and I desire to speak with the utmost caution in regard to it. I find, however, various circumstances that lead me to think that the temperature of the

British seas underwent, at that time, a sudden and decided change.

Mr Bryson, in a Paper read before the Edinburgh Physical Society, says :—

> "At the present time, a well marked line indicates the height of the tides. Among the many islands in the Forth, on every rock, the patella may be found depressing with its foot the solid rock, making as it were a nest for itself; but you may search in vain for any patella marks twenty-five feet above the sea level on Inchkeith or Inchcolm. At Joppa, hundreds of the holes of the pholas may be seen, with the living inhabitant quietly reposing, at low-water, in its rocky house. But no advocate of the theory of the rise of the shores of the Forth has yet shown a hole of a pholas with a dead shell in it one foot above the limit of pholas life. But, perhaps, they may say that the *lithodomi* were introduced by the Romans. Until this proof is produced all other arguments are futile."

A more effectual refutation of the "presumption" of a rise of twenty-five feet since the time of the Roman occupation, than that which is afforded by the facts here stated, could not be adduced. I do not concur, however, in the opinion that there has been no upheaval. Other facts, to which attention has already been turned, afford abundant proof that there has been an elevation of our coasts. Mr Bryson's statement, however, certainly shows, that previous to the time when our shores attained their present elevation, there was something in the condition of the ocean around Britain that prevented the growth of the pholas. As I am ignorant of the habits of the animal referred to, I cannot say what the circumstance was that prevented its increase; but I venture to conjecture, that it may have been the cold communicated to the sea surrounding our island by floating ice.

The number of whales, of the species that has been found around Stirling, also leads us to suppose that these inhabitants of the Arctic Seas were more frequently found on our shores in the period that is past, than they are at the present time.

Mr Smith of Jordan Hill says:—

> "The question as to the identity of the flora and fauna of the present period with that of submergence, is an important one. It would perhaps be premature to say with certainty whether they are identical or not. . . . I have endeavoured to institute as rigorous a comparison as I could between the testacea of the two periods, and refer to the catalogues which I have appended to this Paper for the results. It will be observed, that although the greatest proportion of the shells found in these deposits are identical with existing species, there is a certain proportion that differs from them. . . . The catalogues consist of—1. One of the recent marine shells found in that portion of the British seas which extends from the Firth of Clyde to the north-east coast of Ireland, containing 276 species, of which five are new to British fauna. 2. Another of the fossil shells described in this Paper, chiefly found in the same geographical region, containing 180 species, of which about fourteen are unknown or extinct."

Conjecture as to the Time when the Elevation of the Scottish Coasts took place.—After describing the ancient boats found in the Valley of the Clyde, Mr Chambers says:—"We must suppose this to have been a time when already a people instructed to some degree in the arts of life occupied that part of the island." It may have been so, and all these vessels may have been constructed on the banks of the Clyde. But it seems more probable to suppose, that the elaborately finished galleys were the trading vessels of foreigners, who brought the manufactures of a more cultivated community to be exchanged for the skins and furs which the native Caledonians had collected; and that the rude canoes were the boats of the natives who had brought the products of the chase to the appointed rendezvous. The "plug of cork" found in one of the ancient vessels, directs us to Spain as the place from which the traders came. The well known fact that in early times the Phœnicians sent to Cornwall for tin, and that previous to their wars with the Romans, the Carthaginians, originally of Phœnician descent, had flourishing colonies in different places of the Iberian Peninsula, shows that there is considerable probability in our looking on the ancient galleys found in the Valley of the Clyde as relics of that enterprising race.

Though, therefore, it is but a conjecture, there is some reason for supposing that these vessels were submerged, and consequently that the coasts of Britain were elevated at a period subsequent to the year B.C. 600, when the Carthaginians sent out a fleet, under Himilco, to explore the sea and coasts northwards of the Straits of Gibraltar, and seem to have begun their settlements in Spain.

If this conjecture be adopted, the elevation of the Scottish coasts took place some three or four hundred years before the commencement of the Christian Era.

ON THE

ORIGIN OF OCEANIC CURRENTS,

AND

THE INFLUENCE THEY EXERT ON THE CLIMATE OF PARTICULAR LOCALITIES.

THE researches of geologists have brought to light a number of interesting facts, which lead us to conclude, that immediately previous to the present era the climate of Britain, and other parts of Western Europe, was colder than it is at present. The discovery of the remains of quadrupeds, such as the mammoth and reindeer, which are adapted to a more severe temperature than that which now prevails, and the finding of beds of shells of species that now are found alive only in more northern regions, afford sufficient evidence of a Boreal, or subarctic, epoch.

Farther inquiry leads us, in the same manner, to believe, that in times yet more remote a greater rigour prevailed; and that at a time very ancient, according to the views of the historian, but recent, when compared to the ages of geology, there was a Glacial epoch, when our valleys were submerged under an ocean laden with ice, and our mountains were covered with glaciers and perpetual snow.

Again, persevering in these researches, we find traces of a period when a temperature prevailed as genial as that of the present day.

As was to have been expected, speculative philosophers have not been slow in adducing hypotheses in regard to the changes which this portion of the globe has undergone. Some have supposed that the influence of the solar beam is liable to fluctuation, and that the average heat of the whole globe is, in consequence, liable to variation. Others have imagined that the sun and his attendant planets are travelling in a mighty circuit around some distant centre of attraction, and that, in the vast expanse of space, they pass alternately through regions of heat and regions of cold. These theories may be true. There is nothing impossible, nay, there is nothing improbable in them; and it may be found, that only by adopting one or other of them we shall be able to explain the phenomena of the Azoic ages. Meantime, no evidence can be adduced in their support, and sound philosophy, therefore, tells us to lay them aside.

Sir C. Lyell speaks of these changes of climate as if they were to be attributed to time alone. When referring to the human remains that are found in the neighbourhood of Liége, he says:—

> "When we desire to reason or speculate on the probable antiquity of human bones found fossil in such situations as the

caverns near Liége, there are two classes of evidence to which we may appeal for our guidance.—First, considerations of the time required to allow of many species of carnivorous and herbivorous animals, which flourished in the Cave period, becoming first scarce, and then so entirely extinct, as we have seen that they became before the era of the Danish peat and Swiss lake dwellings. Secondly, the great number of centuries necessary for the conversion of the physical geography of the Liége district from its ancient to its present configuration; so many old underground channels, through which brooks and rivers flowed in the Cave period, being now laid dry and choked up."

In this statement we find one of the strangest fallacies. He describes great effects, and he speaks of "considerations of time;" but he does not so much as allude to the forces that produced the effects. He assumes that the changes referred to were produced by some slowly operating cause; but he does not tell us what that cause was. He seems entirely to forget that time alone, without some co-operating influence, can produce no effect whatever. He speaks of the time required to allow of many species of animals to become first scarce and then extinct, apparently forgetful of the fact, that though, in consequence of death ensuing through the natural infirmities of the body, time may be said to kill the individual, time does not destroy the race. If the physical condition of the country had remained unaltered, and no new cause of death had appeared, the fossil elephant, the cave bear, and their early associates, had been still alive. The cause of their extinction must be sought in some change affecting the climate of the district in which they lived, or in the arrival of some new and formidable assailant. A succession of ages would not have thinned their numbers, if the circumstances in which they were placed had remained unchanged; but the passing away of a boreal climate, and the introduction of what must have been to them an enervating one, which might either induce disease, or render them weak; more especially if combined with the destructive weapons of a daring and intelligent adversary, such as man, would speedily sweep them away.

The "conversion of the physical geography of the district" has no connection with the subject of our present inquiry. We do not, therefore, at present refer to it.

If instead of attributing mighty changes to time, when, in fact, time alone can produce no effect whatever, or speculating in regard to agencies that are altogether unknown, we direct attention to the agencies whose operations we can trace, we very soon find that all the variations of climate that have occurred, at least in Western Europe, admit of a simple and satisfactory explanation. They all may be attributed to the effects which naturally follow from changes in the currents that are found in the ocean.

I propose, therefore, to consider the origin of these currents; the influence they exert on the climate of particular localities; and, the arguments which show that the changes of temperature which Britain has undergone may be attributed to the alteration of oceanic currents.

ORIGIN OF THE CURRENTS THAT ARE FOUND IN THE OCEAN.

It is generally allowed, and seems to be unquestionably true, that all the currents which agitate the air must be attributed originally to the unequal distribution of the solar heat. The equatorial regions, exposed more directly to the influence of the sun, have a larger amount of warmth communicated to them than that which is received by the Frigid zones, and a portion at least of this warmth is carried by the aerial agencies to the colder regions of the globe. Some of the heat that falls on the intertropical lands passes by radiation into space; but the larger portion of it is communicated by contact to the air which lies above them. The air thus warmed, and consequently rarefied, rises upwards, and flows northward and southward to the poles. In like manner, the air which lies above the intertropical seas receives, from contact with the heated waters, a portion of the heat which they derive from the sun, and, warmed and rarefied, this air also ascends and flows toward the colder regions. These aerial currents are modified in their course by various causes which change their direction and their force; but whatever these modifications may be, the ultimate tendency of the currents of heated air is towards the poles, while a counter current of colder air comes to the equator.

As there is nothing to interrupt the currents of air, their influence continues from age to age unchanged. They raise the average temperature of the Arctic and

Antarctic circles, but have no particular effect on one locality more than on another.

Those parts of the Torrid zone which are covered with the deep, receive the same amount of solar heat as those that are occupied by the land. Some of the heat which falls on the ocean, like that which falls on the land, is lost by radiation into space. There is also a portion communicated to the air, to which we have already referred; but the larger portion is expended in warming the water at the surface. The water thus heated becomes expanded, and consequently lighter than that which occupies the depths below, and, like the air which has been heated by contact with the intertropical land, it flows northward and southward to the poles. The Gulf Stream on the coast of America is one of the most striking examples of these currents.

If we look on this heating, and consequent expanding of the water in the Torrid zone as the origin of the currents that flow to the colder parts of the globe, it follows as a necessary inference, that the larger the expanse of water that is exposed to the rays of the sun, the larger will be the current that is produced. And, on the other hand, it is equally evident, that the smaller the extent of watery surface that is exposed to the solar heat, the smaller will the current be.

This seemingly self-evident inference has not always, however, been adverted to. Sir C. Lyell, in his "Principles of Geology, says:—

"Some have been induced to infer that there never has been any interruption to the agency of the same uniform laws of change. The same assemblage of general causes, they conceive, may have been sufficient to produce, by their various combinations, the endless variety of effects of which the shell of the earth has preserved the memorials. The greater warmth that seems to have prevailed in some former periods of the world's history, is not to be ascribed to a greater degree of heat in the globe itself, but to a different distribution of land and water. If we were to imagine all the land to be collected together in equatorial latitudes, and a few promontories only to project beyond the thirtieth parallel, the mean heat of the earth's crust would augment. A remarkable uniformity of climate would prevail amid the archipelagoes of the temperate and polar oceans, where the tepid waters of equatorial currents would freely circulate. We might expect in the summer of the great year, plants allied to genera now called tropical. Forms now confined to arctic and temperate regions would almost disappear, coral reefs would be prolonged again beyond the arctic circles, and droves of turtle might again begin to wander through regions now tenanted by the walrus and seal."

To this hypothesis Sir Charles refers with evident satisfaction in his " Antiquity of Man," p. 363.

Unfortunately for this theory, it is manifestly impossible that " the tepid waters of equatorial currents could freely circulate" at a time when the Torrid zone is supposed to have been almost entirely occupied by land. In the circumstances conjectured, a larger amount of heat would be raised from the land and carried by the air, and the average temperature of the earth would undergo no change. But it is manifestly impossible that any equatorial current could flow where there was no equatorial ocean out of which it could come.

While these streams, from the sunnier climes, pursue their course towards the colder regions of the globe, counter currents come back again towards the warmer. The cold, and consequently condensed and heavier water around the pole, flows as naturally towards the equator, as that which is heated flows to the poles. When the ocean is very deep, and no land interferes with the movements of the water, the returning stream will flow underneath the other. When the water is comparatively shallow, it must seek a separate channel. Such a return stream as we now speak of, laden with its floating icebergs, comes from the Arctic Ocean through Davis Straits, and passes the coast of Newfoundland.

If there were no continents, or large islands, to interrupt their flow, the natural course of the equatorial streams would be northward and southward, with a deviation to the east, in consequence of the earth's revolution on its axis. But in the northern hemisphere at least, the manner in which the land and water are distributed prevents these currents from flowing in this direction. They consequently occupy those channels which the natural configuration of the globe provides.

These channels are not permanent and continuous; on the contrary, they are liable to great and very remarkable changes. There are evidences, for instance, not to be mistaken, that the State of Massachussets, and the surrounding parts of the United States of America, had at one time formed the bottom of a stream, which flowed from the north, and carried along with it masses of ice loaded with large pieces of rock. Similar evidences of polar currents are found in Britain, and marks have been discovered on our own hills which show that icebergs had passed over them when they were sunk more than a thousand feet below their present level. By what channels the equatorial waters flowed in those times we cannot tell. These tepid currents carry with them no floating masses, to leave to future ages the traces of their path. We know the course which was pursued by the stream which carried down its treasures of ice to cool the intertropical seas; but we cannot tell in what direction the other currents flowed.

INFLUENCE OF OCEANIC CURRENTS ON THE CLIMATE OF PARTICULAR LOCALITIES.

As to the influence of these currents, all will at once allow that they must affect the temperature of the *seas* into which they are carried, cooling the warm and warming the cold. This, however, is not the effect to which I wish especially to direct attention. They also affect the temperature of the air above them, and the climate of the countries towards which their course is directed. The tepid waters impart a portion of their warmth to the breezes that sweep over them; and these winds thus becoming warm, mitigate the rigour of the colder regions over which they flow.

This conclusion is by no means universally allowed. In a lecture delivered before the Royal Institution a few years ago, and afterwards published, the lecturer maintains that the Glacial period was contemporaneous all over the world. He adduces reasons which led him to conclude that the land had cooled more rapidly than the sea, and then assuming that the watery exhalations from a tepid ocean, condensed by the rapid radiation from the polar circles, would produce remarkable cold, he tells us, " the sole cause of the phenomena of the Glacial epoch was a higher temperature of the ocean than that which obtains at present."

In his address to the British Association at Bath, Sir C. Lyell speaks of warm moist air from the south producing cold in the north, as if that were an opinion generally entertained. When he refers to the influence of the sirocco, or wind from the desert of Africa, in melting the snows of the Alps, he, in the first place, adduces arguments which show that in the Post-Tertiary period that desert had been covered with the deep, and then goes on to say:—

> " What mighty effects may we not imagine the submergence of the Sahara to have produced in adding to the size of the Alpine glaciers? The action of the south wind was not in abeyance, but its character was entirely different, and of an opposite nature. Instead of passing over a parched and scorching desert, it would plentifully absorb moisture from a sea many hundred miles wide, and when, after complete saturation, it struck the Alps, it would be driven up into the higher and more rarefied regions of the atmosphere. Then the aerial current, as fast as it was cooled, would discharge its aqueous burden in the form of snow, so that the same wind which is now called ' the devourer of ice' would become its principal feeder."

In this opinion I cannot possibly concur. There is no fact in science better established than that heat is absorbed when water is transformed into vapour, whether that vapour occupies a chamber by itself in the form of steam, or is diffused through the air; while, on the other hand, the heat formerly latent, as the phraseology of former times expressed it, is set free by the condensation of vapour into water or ice. The deposition of moisture, more especially in the form of hoar frost and snow, is so generally associated with cold, that some, perhaps, may be led to regard it as the cause which produces the cold. In doing so, however, they mistake the effect for the cause. The fall of the snow is not the originating source of the winter's severity, but is the consequence and evidence of the freezing temperature that at that season exists in the atmosphere.

A current of heated air, whether it be dry, or saturated with vapour, must produce warmth in any object against which it is directed, if the temperature of that object be lower than its own. If saturated with vapour it may deposit moisture; but, at the same time, it must impart heat. The laws that regulate the radiation of heat from the globe may not, perhaps, be fully understood, but that the south wind should have "its character entirely changed," that its nature should become altogether opposite in consequence of passing over the waters of a tepid sea, is utterly inconceivable. It certainly would not be so warm as it is when passing over a torrid plain, but it could never be "the principal feeder of ice."

Instead of entering into an elaborate refutation of Sir Charles' suppositions, I need only refer to the fact that the wind from the south-west, which follows the course of the Gulf Stream, comes to our shores at the present day in precisely the same condition as that which he ascribes to the sirocco of the Post-Tertiary epoch. It is warm, and it is saturated with moisture. That western breeze, as is well known, though it brings a superabundance of rain and mist to the districts exposed to its influence, does not bring cold. The south-western counties of England and of Ireland are not colder than those on the northern and eastern sides of the islands, but, on the contrary, they are much warmer.

I think, therefore, that there can be no doubt that the oceanic currents from the equator, in every case and circumstance, tend to ameliorate the climate of the districts towards which their course is turned; and, on the other hand, that the currents from the poles have a contrary effect, and produce cold.

INFLUENCE OF OCEANIC CURRENTS ON THE TEMPERATURE OF EUROPE.

Directing attention more especially to our own land, all concur in saying, that Britain enjoys at present a temperature exceptionally mild, far higher than that of other countries under the same parallel of latitude.

This is usually, and with evidently good reason, ascribed to the Gulf Stream, which comes to us from the equatorial seas of America, as is shown not only by the observations of hydrographers, but by the nuts and fruits from the West India islands which it brings to our shores. We must further remark, that the heated water from the north-east coast of Africa having no eastward outlet, though a part of it may enter the Mediterranean through the Straits of Gibraltar, must in a great measure flow northwards along the coasts of Portugal and Spain. There is thus a variety of concurring circumstances which serve to explain the anomalous climate with which we are favoured.

Now let us suppose that these peculiarly favourable circumstances were changed, that the Sahara was again submerged, and thus permitted the heated water of the eastern part of the Atlantic to flow through it; while at the same time such an alteration was made on the channels of the oceanic currents on the coast of America, that the Gulf Stream was made to flow northward through Davis Straits, or along the coast of Greenland. In such circumstances, Europe would be surrounded with a Polar stream, more especially if, at the same time, there were such a depression of its western coasts as would form a channel deep enough to attract towards it the current from the north. This would produce a cold as peculiar as is our present warmth. Of course we cannot tell what the courses were in which the currents flowed in former times, but we can confidently affirm, that if changes such as we have supposed were to take place, the effect would be such as we have described. I now refer to some facts which show the probability of Europe having been in the condition which I have pictured.

During the Glacial Epoch, Europe was Surrounded by the Water of a Polar Stream.—Some have supposed that the Glacial epoch was contemporaneous over the globe, and that it was produced by agencies unlike those that we now find in operation. This conjecture is refuted by the very facts by which its existence is proved. It is in consequence of our being able to trace the action of icebergs and glaciers, that we know that such an epoch occurred; and what are icebergs and glaciers, and what is the origin from which they come? An iceberg is a frozen mass carried along by a Polar stream. If there were no warm equatorial oceans to send forth a counter current, and feed the Arctic Seas, there would be no source to supply the ice-bearing flood. A glacier is in fact a river of ice, slowly flowing down the mountain side. It has a source, and it has a termination. If there were no intertropical seas to supply the snow and vapour that feed the glacier above, and to receive the water that runs from it below, no glacier could exist. Glaciers and icebergs may in truth be said to owe their origin to equatorial warmth.

In the Glacial epoch the natural agencies were the same as they are at the present day.

Ameliorations of Temperature have been coincident with Changes of Elevation.—We usually find that the higher any country is elevated above the level of the sea, the greater is the coldness of its climate. But in regard to Britain, we discover facts which show that in proportion to the rise of the land there has been an increase of warmth.

We farther observe, that all the changes of temperature which have occurred since the Glacial period have been coincident with changes of elevation.

When the British islands were sunk from a thousand to fifteen hundred feet beneath their present level, those parts which were not submerged under the deep were covered with ice and perpetual snow. Now, the climate has been so ameliorated, that we find them covered with leafy forests and grassy pastures.

At an after period a rise of some eight hundred feet seems to have taken place, and then we find the remains of a fauna such as now exists in the Arctic Seas.

A farther elevation introduced the epoch when creatures like the rein-deer and mammoth, especially fitted for living in an Arctic region, were intermingled with animals that still inhabit the country.

Again another rise of the land, variously estimated at from forty to a hundred feet, introduced our present peculiarly temperate climate.

The general accuracy of these statements, taken from various sources, will, I presume, be readily allowed. Step by step our island seems to have risen above the sea, and still as it rose the warmth of the climate increased. This remarkable correspondence between elevation of level and warmth of temperature evidently shows that the peculiarity of our climate, in some way or other, depends on the action of the subterranean forces by which changes of level are produced.

If this fact be taken in connection with what I have before stated in regard to oceanic currents, the probability of the hypothesis which I suggested will, I think, be readily allowed.

Manner in which the Elevation took place.—Another inquiry remains to be made. We must endeavour to discover whether the rise of the land, and, consequently, the amelioration of the temperature of Western Europe, was the result of a slow continuous movement, like that which is said to be going on in Sweden at the present time, or whether it was effected by a succession of sudden upheavals, separated by periods of repose.

I have already proved, in a former Paper, that there has been no elevation of the coasts of Britain since the invasion of the Romans, and that the last upheaval was sudden. If this be the case, we are naturally led to conclude that the preceding steps of the elevating process had also been sudden.

This supposition is confirmed when we consider the evidences we have of previous movements. In Mr Chambers' volume on "Sea Margins," we have described to us a curious succession of terraces which point out the various heights at which the sea had formerly stood. These terraces must be regarded as representing periods of rest. If the land be advancing on the sea, the action of the wave has a tendency to produce a horizontal beach, a few feet above high-water mark, and a similar deposit below the reach of the tide. In some places, only one of these deposits may be discovered; in others, both may be traced. The formation of these terraces can only take place when, for some length of time, there is no alteration on the relative height of land and water. If the coast be slowly and steadily rising, no such deposit can be formed. The action of the billow, in that case, will result in a sloping bank.

If, therefore, the coast of Britain exhibits a succession of sea margins, such as Mr Chambers describes, there is certainly a probability that the countries of Western Europe were raised by a succession of sudden elevations, though, of course, we cannot say with certainty that such was the case.

Whatever the cause may have been that produced it, it seems evident that the amelioration of the climate corresponded to the elevation of the land, and we therefore infer that the length of time required for the change of temperature, and consequent extinction of species, must also have corresponded to the manner in which that elevation took place. If the rise of level had been slow and uniform, such also must have been the increase of warmth, and we might then, with Sir Charles, look on "considerations of the time required to allow of many species of carnivorous and herbivorous animals becoming first scarce and then entirely extinct," as affording an argument for the great antiquity of man, who seems for a time to have been contemporaneous with these extinct mammalia. If the elevation of the land took place by a succession of sudden steps, such also must have been the improvement in the climate, and his argument loses its force.

We cannot measure the time which subterranean agencies require. The raising of a continent may be the work of an hour. In a single season the Boreal age of Britain may have been succeeded by the warmth of the present time. The facts and arguments which I have adduced show, I think, the probability of this supposition. Instead of our being required to attribute to man a fabulous antiquity, because he was contemporaneous with the cave-bear and mammoth, it may be but little more than two thousand years since he carried on against them his sylvan war, and finding them enfeebled by the unwonted mildness of the climate, made of them an easy prey.

ON THE

ACTION OF FLOATING ICE.

AS EXEMPLIFIED IN THE VALLEY OF THE SOMME.

THE discoveries recently made in the Valley of the Somme, have been so productive of debate among geologists, and the conclusions which some have drawn from them are so startling, that it is of evident importance the whole subject should be carefully investigated.

I take the liberty, therefore, of bringing before the Association a few remarks, which I wish to be regarded as suggestions for those who may have the means and leisure for farther prosecuting the inquiry, rather than a full and satisfactory explanation of the peculiar appearances which the valley presents.

I shall endeavour, in the first place, to describe the nature of the agency to which I think the peculiarities which have excited so much attention are to be ascribed, and shall then direct attention to the Formation of the Valley—its Lower and Upper Level Gravels,—and its Splinters of Flint.

On the Action of Floating Ice.—Some of the effects produced by ice on the varied materials which compose the surface of the globe have been carefully examined, and seem in general to be fully understood.

The researches of Principal Forbes have shown that the glacier is, in fact, a river of ice, which, impelled by its own weight, flows down the mountain in a sluggish stream, and farther inquiries have fully illustrated its effects. Pressing with its enormous weight on the rocks below, it grinds them down. Their surface is thereby smoothed and polished. The greater part of that which is abraded is carried off in the form of mud by the water which percolates through the glacier, while the harder and larger fragments are carried down to the lower edge of the great frozen mass, and are there thrown up in a moraine or mound of gravel.

The action of the iceberg is somewhat similar to that of the glacier. These huge masses, carried along by currents in the ocean, rub down the rocks against which they are carried, and gradually reduce them to powder, which, mingling with the water, is carried along with it, and is finally deposited in beds of sand and clay. We can trace the action of the icebergs that in a former epoch floated over our island, in the polished surfaces which we find in various parts of the country, in the grooves and scratches that sometimes mark where their course had been, and in the beds of "boulder clay" that are so frequently found all over the country.

Besides these, there is another variety of ice action which has not as yet received that attentive consideration which is necessary for rightly estimating its influence. I refer to the effect of floating ice, when put into rapid motion by tidal currents. In such a case, the weight of the moving mass is but a trifle compared to that of the glacier and iceberg, but when a rapid motion is communicated its impetus is great. This is shown by the effects which are produced by the ice brought down by the rivers in America.

It is necessary farther to remark, that the action of ice floating on a rapid current differs in its nature from that of the iceberg and glacier. In them we have a continuous pressure slowly grinding down the rocks against which they are impelled; in the other, we have a percussive power, like that of the battering ram and hammer, which produces its effect by a blow, so that while softer substances are reduced to powder, hard and unyielding rocks are broken into splinters and angular fragments.

Geological research has made it evident, that in the Glacial epoch Western Europe was subjected to the influence both of the iceberg and glacier. There is also every reason for supposing that the period of extreme cold was followed by a time when a subarctic temperature prevailed, and when that part of the earth which we inhabit had a climate like that which is now found in the northern parts of Canada and adjoining provinces of British America.

In these regions, we know that floating ice exerts a powerful influence, and we may therefore conclude, that similar causes must have produced similar effects in France and Britain, during the time when the rigour of the Glacial epoch was passing, step by step, away.

I shall now endeavour to show that the peculiarities which characterise the Valley of the Somme may be more satisfactorily explained, by referring them to the action of ice impelled by tidal currents, than by any hypothesis hitherto advanced.

Formation of the Valley of the Somme.—The Valley of the Somme, as described by Sir C. Lyell and Mr Prestwich, is a long narrow trough, upwards of thirty miles in length. It is about one mile in average width, and from two to three hundred feet in depth. It has been hollowed out of a bed of "chalk with flints."

On the sloping sides of the valley are two level terraces, composed of sand and gravel, with occasional beds of clay. The gravel consists of fragments of rock, the same as those which are now found in the district drained by the Somme. In some places, where the terraces have been opened for industrial purposes, the bones of extinct mammalia, such as the mammoth, have been found. In the terraces, fragments of rock are sometimes found with the edges unbroken, as if they had been brought down by floating ice; and there are contortions in the beds of sand, which show that these frozen masses must have exerted considerable influence at the time when the terraces were formed. Sea-shells are found mingled with the gravel in these terraces as far up as Menchecourt, about ten miles from the mouth of the river.

The bottom of the valley is occupied by a bed which

Sir Charles characterises as peat, and describes as being from ten to thirty feet in thickness. Mr Prestwich speaks of it as alluvium. Underneath the peat is a layer of gravel, "age undetermined." M. Gerard says:—

> "The Valley of the Somme is covered with two feet of soil; below that there is from six to ten feet of moss from Amiens to Pecquigny. The lower part of the City of Amiens is built upon a subsoil of moss, twelve feet deep. In some places there is below this a stratum of marl, or a bank of sand and sea-shells."

If we rightly understand the descriptions that have been given of it, the Valley of the Somme may be regarded as a long, shallow, flat bottomed trough, hollowed out of a uniform level bed of chalk. Its formation seems to be altogether unique. Some valleys originate in dislocations of the strata, through the action of subterranean forces; but here there is no trace of such dislocation. Other valleys have been excavated by torrents from the surrounding hills; but here there is no trace of any river current capable of producing the hollow through which the Somme flows into the sea. To produce such an effect its volume must have been large, the water having been derived from a large district of country, and its course must have been rapid. The gravel, however, on its banks, consists of fragments of rock, the same as those found in the district now drained by the river, and that district is but small; and instead of a rapid fall towards the sea, there is but a few feet of descent from Amiens to the ocean.

Some valleys may be attributed to glacier action; but in the neighbourhood of the Somme there is no trace of any glacier having ever existed. There seems to be but one cause to which its formation can be assigned, and that is the action of floating ice carried backwards and forwards by a tidal current. If we suppose the Somme at first to have flowed into the sea through a little narrow creek, the ice formed on its surface during the period when a boreal climate prevailed, must have rapidly worn away the chalk which formed its banks. When the creek enlarged, so that it became a narrow frith, that frith would, in a great measure, be filled with fresh or brackish water, which would be frozen over in winter. The flux and reflux of the tide in such an estuary, like that which we find in the Solway Firth at the present day, would produce powerful currents, and give to the masses of ice, with stones and gravel frozen to their bottoms and edges, such an impetus as a substance so soft as chalk could not long resist. If the sides of the depression had been formed of tougher rock, the same effect would not have been produced; and the fragments broken off them would have formed extensive beds of gravel, which would in some degree have lessened the action of the ice. But the chalk when abraded would float lightly in the water, and be carried out to the sea, leaving only the flints behind. In so far as I can perceive, it must have been in such a manner as this that the Valley of the Somme was originally excavated.

Hitherto I have not seen any attempt to explain the manner in which the hollow originated; but it seems to be impossible to understand aright the peculiarities which the valley exhibits, without having reference to the causes which led to its formation.

Lower and Upper Level Gravels.—On the sloping banks on either side of the Valley of the Somme there are deposits consisting of gravel, sand, and clay, which assume the form of terraces. Sir C. Lyell describes them as

> "The lower level gravel covered with fluviatile loam, twenty to forty feet thick; and the upper level gravel, with overlying loam, in all, thirty feet thick."

When speaking of their origin, he says:—

> "The valley must have been excavated nearly to its present depth and width when the strata of the upper level gravel were thrown down, and after the deposits of the upper and lower level gravels had been formed in succession, the present valley was scooped out, patches only of them being left."

If I understand aright the descriptions he has given, the upper gravel is thirty feet above the lower one, and looking at the accompanying plates, the section of the valley seems to exhibit an appearance exactly resembling that which would be presented by any narrow frith of the ocean if it were to be elevated above its former level by a sudden upheaval.

In order to understand the effects produced by the Natural Agencies in the times that are past, it is evidently essential that we should make ourselves acquainted with the effect of the operations now going on. And it seems to me that no little confusion of *thought*, in reference to the subject now before us, has been occasioned by mistaken views in regard to the formation of littoral deposits.

This makes it necessary to introduce a few remarks on the operation of the natural forces by which these deposits are formed.

If we trace the movements of a pebble, or shell, lying on the beach, we observe, that when the waves strike against the shore the pebble is hurried upwards towards the land, but when the billow retreats it is carried back. This process is repeated again and again. If the retreating wave prove the stronger, the stone is carried farther and farther back, till at last it reaches a depth where the agitation of the surface can no longer disturb its repose. Other pieces of stone or shell are in like manner brought down and laid beside the former, while others are carried still farther into the sea. "The sudden deepening of the water, two or three fathoms below the low-water mark," which Mr Smith of Jordan Hill speaks of as "probably caused by a line of terraces now covered by the sea," may be regarded as a low level terrace in process of formation.

This deposition of sedimentary matter under the water is not, however, the only deposit that is produced by the action of the waves. While many substances, swept backwards and forwards by the billows, are gradually carried into the deep, others are thrown up on the beach, and there left dry. The material thus cast up, of whatever kind it may be, does not find a final resting-place till it has been carried up beyond the disturbing influence of the highest tide. When the sea is encroaching on the land, no such deposit as that to which we now refer can be formed; but when the quantity of debris brought along by the tide is large, and the land is gaining on the sea, the gravel, sand, and shells thus thrown up form a terrace, which is sometimes of considerable extent. Its height above ordinary high-water mark depends on the strength of the waves. As the deposit is of course largest when the sea is most disturbed, these terraces are frequently spoken of as the "storm-wave beach." Generally speaking, they may be described as from five to fifteen feet above ordinary high-water mark.

When the matter thrown up consists of shingle, of such weight as to resist the action of the wind, it remains either altogether bare, or is covered with only a few inches of sandy soil, and forms a comparatively level surface. When the quantity of sand thrown up is large, it is formed by the force of the wind into hillocks of considerable height, and not unfrequently spreads over a large extent of ground.

In regard to the deposits which are left by the retreating wave, there are so many and such varied influences affecting their formation, that no description of their outline can be given that will apply to them all. In general, the descent of the shore at first is rapid, but it becomes more gradual as it goes down into the deep. Deposits possessing a comparative horizontality of surface are found at all depths, from ordinary high-water mark to two or three fathoms below the lowest ebb; but in consequence of the currents that prevail in the ocean, their horizontality is not by any means perfect.

Another circumstance to which greater regard should be paid than it has hitherto secured, is the composition of these deposits. When we direct attention to the materials of which they consist, we find that they vary according to the position in which the deposit is formed. In the high-water level, or storm-raised beach, we find shingle and sand intermingled with shells that have been thrown up irregularly, and are generally broken. Farther down the slope, towards the sea, the shells that are mixed with the sand are not so much injured as those on the high-water terrace. Many of them are quite entire, but they all bear marks of having been forcibly removed from their original position. As we approach low-water mark, we discover those species of shells that burrow in the sand in health and vigour. A little above and below low-water mark, the cockle has its appropriate locality, and in the greater depths the mussel and oyster abound.

In all investigations into littoral deposits, whether of recent or of former epochs, a careful examination of the materials of which they are formed, and more especially of the nature and condition of the shells which they contain, is as necessary for the inquirer who wishes to study the lessons which they teach, as an acquaintance with fossil remains is for the geologist, when engaged in classifying the stratified rocks.

If we now turn to the description given of the level gravels of the Somme, and draw a comparison between them and the sea margins and level terraces on our own shores, I see no difficulty in ascribing their formation to the action of the tide. The sea-shells which Sir Charles tells us were found at Menchecourt, ten miles from the sea, show that the lower part of the valley must at one time have been an estuary connected with the ocean. According to M. Gerard's statement, "the lower part of the City of Amiens is built upon a subsoil of moss, twelve feet deep. In some places there is below this a stratum of marl, or a bank of sand and sea-shells." This seems to indicate that the sea had flowed forty miles up from the mouth of the river. The upper level gravel may therefore be regarded as the storm-wave beach of a former epoch, and the lower levels as the beds that at that time were formed under high-water mark. There is every reason, therefore, for regarding them as contemporaneous, and not separated, as Sir Charles supposes, by a vast interval of time.

No data are given by which we can form an accurate opinion in reference to the *composition* of the level gravels.

The hypothesis brought forward by Sir Charles and Mr Prestwich supposes that the Valley of the Somme was at first filled with gravel, and then scooped out by the water of the river. This involves a physical impossibility. The Somme, at the present time, drains but a limited extent of country, and the fragments of rock found in the level gravels show that the limits of the area from which it drew its supplies was the same in former times as it is now. It could never have brought down a great volume of water. The fall between Amiens and Abbeville is only two feet in a mile, and it would seem that the descent between Abbeville and the sea is still more gentle. Such a river might be imagined, in the course of some vastly extended period, to have filled up the valley with sand and mud, but it could not possibly have cleared out the gravel with which these gentlemen suppose it to have been filled.

Splinters, or Flakes of Flint.—When making pits for various purposes in the level gravels on the banks of the Somme, the workmen frequently dig up splinters, or flakes of flint. By some they are spoken of as "flint implements," and from their having been found in the tombs of the ancient inhabitants, and among the ashes of their fireplaces, it seems pretty evident that they were sometimes employed as knives and hatchets, and as points for their spears and arrows. Some attribute their formation to the hand of man, and finding them in large numbers, even in the earlier part of the age of the great mammalia, have drawn from that the conclusion that man must have lived in a savage state for untold ages on the banks of the Somme.

As I have not visited the place myself, I am happy to be able to refer to a gentleman—Mr Whitley of Truro—who has not only examined the district of the Somme, but who has carefully studied the subject, as his pamphlet on "Flint Implements" shows.

"It is important to observe, that the undoubted flint arrow-heads of the recognised Stone age, which preceded that of Bronze, are very carefully chipped into form, barbed and pointed, of uniform workmanship, and of a size adapted to the purpose for which they were designed. An inspection of the large collection in the British Museum convinces the mind at a glance that they were made by man. But the rough flint flakes, called arrow-heads, of the First Stone age of Lyell, are of all sizes, seldom pointed, never barbed, having a conchoidal fracture on one side, and an angular one on the other; and they are so rude in form, and so deficient in the evidences of design, that the judgment at once hesitates to pronounce them of human workmanship.

"A marked characteristic of the flint tools from the Somme gravel is that they are only chipped into form, and in no single instance rubbed or ground to a point, or cutting edge, and on this mark of distinction Sir Charles apportions the chipped tools to the *First Stone period*, and the ground ones to the *Second Stone period*. Well may he say of these tools, 'that they are so irregular in form as to cause the unpractised eye to doubt whether they afford unmistakable evidence of design.'

"The tools made by man of the recognised Stone age are not only made of flint, but of serpentine, greenstone, claystone, quartz, porphyry, jade, etc. It is far otherwise with the 'tools' of the First Stone period; they are all of flint, and where there is no chalk, or flint gravel, there no 'tools' are found.

"The good and bad are all mingled together. Some bear all the marks of chipping, said to be indicative of human skill, others are much rougher in form, and the whole are intermixed with ordinary flakes and angular split flints.

"These flint flakes are the result of the natural fracture of the flint nodule. I gathered from a heap of flints, broken for the roads at Menchecourt, most perfect flint flake knives, and small delicately formed 'arrow-heads' of the most convincing forms. I have placed flints in the fire and suddenly cooled them, and many of the flakes thrown off were sharp well formed arrow-heads."

" M. Boucher de Perthes says:—' Any one visiting me may count them by thousands, and yet I have kept only those which presented some interest. I have seen them drawn in barrows to metal the neighbouring roads; one would have thought a shower of them had fallen from the sky.'

" In about three acres of land certainly more than three thousand have been exhumed, which is equal to six hundred and forty thousand in a square mile; and as these beds are proved to extend more than twenty miles along the Valley of the Somme, there must be twelve millions in this small area. Other parts of France produce similar supplies. On a spot near Pressigny they are not found singly, but by hundreds and thousands, over an extent of fifteen or sixteen acres.

" In England, the angular flint gravel is a widespread deposit, in which all the flints are fractured, many of the flakes have edges as sharp as a knife, and the great mass of these split flints have the marks of chipping on their surfaces as perfect as on the supposed tools."

These quotations from Mr Whitley set before us with sufficient minuteness the facts on which we rest our opinion in regard to the causes to which we are to ascribe the origin of the flint splinters, or implements, as they have been termed.

I shall, in the first place, state the hypothesis which I have formed myself, and shall then direct attention to those that have been adduced by others.

In so far as I can see, all the phenomena connected with them may be ascribed to the action of floating ice. Masses of ice, two or three feet thick, such as would be formed during the Boreal period on our rivers and estuaries, when driven by the force of the current against the stones and pebbles lying on the shore, would crush them violently together; would break those that, like flint, are of a hard and brittle texture into splinters, and grind down those that are of a tougher and softer composition into pebbles and sand. If we further suppose that the stones lying on the beach when the water was freezing were sometimes embedded in the ice, and this must at least have very frequently been the case, when swept along by the current of the flood or tide, they would be driven with the impetus of the battering ram against those that were lying on the shore, or fixed in the chalk. This hypothesis affords, I think, sufficient explanation of the manner in which these masses of splinters have been formed, which of late have attracted so much attention.

There is another circumstance to which reference may be made. It is a commonly received opinion, though I cannot vouch for its accuracy, that brittle substances are most easily broken in the time of frost. If this be the case, we have a further confirmation of the hypothesis which I have adduced.

I do not pretend to be able fully to substantiate the accuracy of my supposition. The effects that have been produced by floating ice during the Post-Glacial epoch have yet to be investigated. I therefore desire to speak with caution, though I can see, as I said before, no objection to the theory I have brought forward.

I do not think that the conjectures advocated by others are sufficient to account for the appearances that have been observed. Mr Whitley says, that some geologists have attributed the formation of these splinters to the disturbing forces which disrupted the chalk strata. Others have ascribed it to lightning. He himself thinks it more probable that it has been the result of unequal expansion from a change of temperature.

As for the speculation of M. Boucher de Perthes, it is altogether improbable. When speaking of these splinters, he says, "Any one visiting me may count them by thousands, and yet I have kept only those which presented some interest." And at the same time, there is not in all his collection, so far as I can ascertain, a single stone affording unequivocal evidence of human workmanship. Surely there can be no good reason why these rude productions should be ascribed to the hand of an intelligent agent such as man.

All these splinters, regular and irregular, are mixed up in the original deposits together. They are not separated one from the other, as if some had been set aside by design. It is not reasonable, therefore, to say those which assume a regular form have been fashioned by man, while the others have been produced by some agency unknown. We must attribute the origin of both to the same cause—to some cause capable of producing the whole effect.

The immense quantities that have been found,—and till we have explored the gravel at the bottom of the valley we may presume it is but a small proportion of them that have been found,—and their wide distribution over all the chalk districts both of England and France, preclude the idea of these splinters having been manufactured by man, even in the course of lengthened ages.

After examining the whole subject, as fully and as carefully as I can, I can see no reasons for concluding that the facts discovered in regard to the *First Stone age* afford any foundation for the arguments that have been deduced from it in regard to the antiquity of man.

ON THE

NATURE AND POSITION OF MAN.

AT first it appears a very easy task to point out the characteristic marks that distinguish man from the lower orders of animals. When, however, we proceed in our investigation, we find many difficulties besetting our path, and though we feel, instinctively as it were, that there is a great, an essential, difference between the rational and the irrational, we find it by no means easy to point out accurately and minutely wherein that difference consists.

Those who have occupied their thoughts with metaphysical speculations, or with the study of mental and moral science, not only maintain that there is an essential difference between the reasoning soul of man and the principle of instinct that is found in the beast; but appear to be unwilling to allow that the lower creatures possess that measure of intellectual capacity which they manifestly exhibit; while in reference to the connection that subsists between the body and mind of man, some of them not only deny that the rational powers are dependent on cerebral development, but ridicule the idea that the size and form of the brain is, in any degree, even the index or measure of the faculties and affections.

On the other hand, those that have been accustomed to anatomical researches, who have directed their attention more especially to the bodily constitution of animals, and to the physical characteristics that distinguish genera and species, are frequently found speaking of rational thought as if it were merely a function of the brain, and look on man as differing only in degree of endowment from the creatures around him. Some of them maintain, that the only distinction between his faculties and those of the beasts consists in their superior strength and activity. Others enumerate certain powers and emotions which they regard as peculiar to the human race; but these powers are represented as precisely similar in nature and character to those that are found in other creatures. According to either of these hypotheses, the faculties possessed by man and those possessed by the beast are substantially the same. To use the language employed by the author of "The Vestiges of the Natural History of Creation," "The difference between mind in the lower animals and in man, is a difference in degree only, it is not a specific difference."

Another source of that diversity of opinion that prevails in regard to the nature of man, arises from the still more deeply to be regretted difference of opinion that exists in regard to the nature of God, and the duty we owe Him. Some of those who are actuated by a reverential fear of the Great Governor of all, seem to shrink from any examination into the connection that subsists between matter and mind, between the rational soul and the bodily organ through which it acts, and seem to regard any comparison between it and the spirit of the beast, which goeth downward to the earth, as if such inquiries naturally led to the denial of a God.

On the other hand, those that openly disavow any belief in an all-pervading, ever-acting Providence, seem to welcome every argument that tends to obliterate the distinction between the soul of man and the animating spirit of the beast. This has been shown by the experience both of the past and of present times. Lord Brougham, in his "Dialogues on Instinct," speaks in the following terms of the so-called philosopher of a former age:—

> "The sceptical, or free-thinking philosophers, always lowered human nature as much as possible. They regarded it as something gained to their arguments against religious belief if they could show the difference to be slighter than is supposed between men and brutes, and that there is a chain of being from the plant, nay, almost from inorganic matter, up to man. They seem to have had a confused idea that this helped them even to account for the constitution of the universe, 'without the hypothesis of a Deity,' as La Place is said to have termed it, when Napoleon questioned him on the remarkable omission in the Mechanique Celeste."

In the present day, Mr Darwin and his associates maintain that man is not only the same in his nature as the other inhabitants of earth, but owes his origin to a mysterious law of development, which, through a lengthened process, transforms the mollusc into a fish, the fish into a reptile, the reptile into a quadruped, and the quadruped into man. This theory, which of necessity excludes the idea of an ever-present Deity, by whom we are continually sustained, and to whom we are responsible, is advocated also by many others of the highest name in the scientific world.

The inquiries we have made have brought us to a very different conclusion. We regard the animating spirit in man as altogether different, both in its nature and in its destiny, from that which is found in the beast. If we confine our attention to the conformation of his bodily frame, we find so many analogies, so many points of resemblance between him and the lower orders of animals, that though a more delicate organisation, and a higher cerebral development, lead him to be regarded as standing at the head of the animated creation, yet there is nothing in the constitution of his material frame that entitles him to be looked on as essentially distinct from the creatures that surround him.

The same thing may be said in reference to the merely animal faculties and feelings. The powers of observation that primarily depend on the bodily senses of sight and hearing, taste and smell, he shares with a large proportion of the whole animal creation. His power of remembering events that are past, of recognising the places he has visited, and of tracing the path he has formerly trodden, does not seem to differ from the recollective faculty of the spaniel that follows him.

A similar remark might be made in regard to a variety of emotions, such as the affection and gratitude that are awakened by acts of kindness, and the distrust and revenge that are produced by deeds of unkindness. In regard, in short, to all those powers and feelings that seem to be more immediately associated with the cerebral development, and to which phrenologists have given "a local habitation and a name," though man occupies the highest place among the creatures of earth, his nature is not essentially different from theirs.

The bodily organs, however, and the animal faculties and emotions, do not constitute the whole of the man. The higher and nobler part of his constitution, the rational soul, is something altogether distinct in its properties and dissimilar in its nature. In addition to the organised framework of the body, which distinguishes the herb and the animal from the earth and the stone, and in addition also to the living, sentient principle, with its corresponding faculties and feelings, by which the animated tribes are distinguished from the herb and the tree, he has a reasoning and immortal spirit altogether distinct from anything found in other terrestrial beings.

As it is only through the animal faculties and senses that the rational soul can acquire any knowledge of that which is external to itself, or hold any communication with other minds, it is difficult to define with precision the peculiar functions that belong to this reasoning power; but it is very evident that we must look on it as standing alone. It is not one of a company, similar in nature, and differing but little in influence, as some have represented it. Its office is peculiar, and its authority is supreme. It is the builder by whom the edifice of demonstration is erected, the other faculties are merely the labourers that bring in the materials. It is the general that directs the onward march of argument, the others are only the scouts that bring in intelligence, the messengers that convey his orders, and the subordinates that execute his commands.

In order to confirm our statement, we shall enumerate some of those peculiarities that seem most clearly to exhibit the characteristic superiority of the human mind over the intelligence of other animals.

The first of these is the power by which we form an idea of a quality or attribute as something distinct and separate from the substance in which it is found. This faculty of abstraction, as some have termed it, enables us to attach a meaning to such words as whiteness and hardness, without having before our minds any particular object in which these properties are found. It enables us to form an intelligent idea of sentiments and emotions, such as hatred and love, without our having any immediate reference to the objects that awaken these feelings. It enables us to compare together the various facts brought under our notice by the animal faculties and senses; it decides upon their nature, and classifies persons and things according to the qualities which they exhibit. It takes cognisance of essential properties, and enables us to reason in regard to the consequences which they may be expected to produce.

The superiority of the rational mind is in nothing more manifest than in the use of speech. The sounds uttered by the lower animals are merely the instinctive expressions by which they make known the desires and sensations which they experience. When the dog, for example, finds himself in want, he indicates his feelings by whining or howling; when he is irritated, he shows his anger by snarling and growling; when he is in pain, he expresses his suffering by yelping; and when startled by a stranger's approach, he intimates his alarm by barking. The utterance of these sounds intimates the feelings that have been excited within him, and awaken sympathy, more especially in other animals of the same species, and thus assists him in obtaining relief. This is its ultimate object and aim. All his varied notes—and there is none of the lower creatures that possesses so extensive a vocabulary—only express present sensations, and beyond that his language does not go. The same statement holds true as to all the signs and sounds that are employed by the various tribes of irrational creatures. The language of man is based on an altogether different principle. It is intended to point out the character and qualities of the persons or objects to which he refers. The first lisping attempts of the child evidence a desire to describe the things that please him as "good," and the things that displease him as "bad." Language is the offspring of the rational faculty, which discriminates qualities, and classifies and arranges objects according to the properties they exhibit. It is the means and medium by which the intelligent soul makes known, not its feelings merely, but its discoveries and conclusions to others.

Another faculty, the possession of which distinguishes man from the other orders of animated beings, is conscience, which includes a power by which we distinguish between right and wrong, and an affection by which we are led to look on the one with approbation, and on the other with condemnation and dislike. Bishop Butler was the first that clearly pointed out the place and authority to which this principle is entitled. He says:—

> "Brute creatures are impressed and actuated by various instincts and propensities; so also are we. But in addition to this, we have a capacity of reflecting upon actions and characters, and of making them an object of thought. On doing this, we naturally and unavoidably approve some actions, under the peculiar view of their being virtuous and of good desert, and disapprove of others, as vicious and of ill desert. That we have this moral approving and disapproving faculty is certain, from our experiencing of it in ourselves, and recognising of it in others. It appears from our exercising it unavoidably in the approbation and disapprobation even of feigned characters; from the words right and wrong, odious and amiable, base and worthy, with many others of like signification in all languages, applied to actions and characters; from the many written systems of morals which suppose it, since it cannot be imagined that all these authors, throughout all these treatises, had absolutely no meaning to their words, or a meaning merely chimerical. It is manifest that a great part of common language and of common behaviour over the world is formed upon the supposition of such a faculty, whether it be called conscience or the moral sense, and whether it be considered a perception of the understanding, or a sentiment of the heart, or, which *seems the* truth, as including both."

Another peculiarity that distinguishes man from the lower creation is his capacity for improvement and onward progress in knowledge. The inferior animals inherit not only the faculties of their progenitors, but in some measure also the knowledge which their parents acquire.—(*See Brougham's* " *Dialogues on Instinct.*") They consequently attain to very great perfection in the circumscribed range of intellectual exertion to which their powers and their desires confine them, but beyond that range they do not pass. No architect could build a nest more suitable for the purposes required than that which the bird constructs for itself; no mechanician could form a honeycomb more mathematically accurate in all its dimensions than that which the insect fabricates. But there is no onward progress in their art. Centuries pass on, and birds and bees continue to build as birds and bees had built before. Very different is the case in regard to man. Unlike the lower orders of creation, he comes into the world utterly ignorant of all that his fathers had learned before. His animal faculties and instincts exhibit in infancy a development far inferior to that which is found in other creatures at a corresponding period of their existence; but in a very brief space of time he excels them all in intellectual acquirements, and manifests an aptitude for learning, and a desire for improvement, to which we can assign no limit, and which must be regarded as clear indications of a nobler nature and a higher destiny.

We may farther remark, that in all men, whether savage or civilised,—excepting, perhaps, a few geologists of the Darwinian school—there is

> **"An anxious hope, a fond desire, a longing after immortality."**

If, therefore, we find in every class of animated beings, that wherever an appetite or instinctive desire is implanted in any creature, the Gracious Creator has provided means for its gratification, this "fond desire" points to a life beyond the grave, and, apart from all arguments from other sources, shows that man has a career before him very different from that which is appointed to the lower creation.

Our review of the various peculiarities that characterise the nature of man has necessarily been brief and imperfect. It is, however, sufficient to show, that amidst the vast variety of birds and beasts and creeping things that now inhabit the earth, man stands apart from all. His bodily organisation, his animal faculties and appetites, resemble those of the other creatures; but the distinctive peculiarities of a rational soul and the aspirations of an immortal spirit are found in him alone.

Although we have endeavoured to state our argument as simply as the nature of the subject would allow, some may perhaps regard our observations as too abstruse and metaphysical for the popular mind. In order to meet this objection, and in order to show even to the young and illiterate the superiority of the mind that is in man to the spirit that animates the beast, we shall direct attention for a very little to the position which he holds among the other inhabitants of earth, which will lead us to the same conclusion as our former inquiry did.

When we examine into the means by which the various classes of animals are supplied with nourishment, we find that, while it is a characteristic of living creatures that they procure the sustenance necessary for their support by their own voluntary exertions, in the case of the lower animals their food only requires to be gathered and then to be eaten. Whether they live on the herb of the field, or on the flesh of other animals, so soon as their provision is found their table is spread and their banquet is prepared. Man, on the other hand, finds it necessary not only to collect with labour and care the substances that minister to his nourishment, but to make them pass through a variety of processes before they can please his palate, or be adapted to his organs of digestion. Notwithstanding, however, these disadvantages, so far is man from being doomed to perish from hunger, there is none of all the creatures that live upon earth that enjoys so rich and so varied a supply of food. In like manner, if we turn our attention to the means by which they are protected from the inclemency of the seasons, we find that the irrational animals, without trouble or forethought on their part, have clothing provided for them appropriate to their nature and to the element in which they live. The bird has its feathers, the quadruped has its hair, and the whale is protected from the cold of the Arctic Ocean by the coating of blubber that lies beneath his skin. Nature provides for man no such protection, and yet there is no creature so comfortably clad. His intelligence and industry furnish him with raiment suited to every region in which he may dwell, and for every occupation in which he may engage. If we look to the means by which the different animals defend themselves against their assailants, man seems at first to be one of the most helpless of beings. The beast of prey has his claw and his tooth, the bull has his horn, and the horse has his hoof—every animal has some means of safety provided by the very constitution of its bodily frame, whether it be its power of resistance or its swiftness of flight. Man, regarded merely as to his bodily organisation, has neither strength to contend with his foes, nor speed of foot to enable him to escape their assault. Yet this creature, unfitted as we might deem him for holding his place among his fellow-citizens of earth, assumes, through the intellectual superiority of the rational soul, the sovereignty over them all. The most formidable of the beasts of prey fall by his weapons, or are compelled to flee from his presence. The bullock and the horse submit to his yoke, and the colossal elephant obeys his behests. Even the elements of nature are made to minister to his pleasure. The torrent, descending from the mountain and hasting to the sea, is arrested in its course to turn his millstone and prepare his food. The devouring flame, through the agency of steam, twirls the spindle and drives the shuttle that supply him with clothing; and the ever-restless ocean is the bearer of his burdens.

Is man, who thus exercises lordship over the lower world, to be regarded as essentially the same as the creatures around him? Is he nothing more than a peculiarly sagacious brute? Is he only a more mature development of the gorilla or the orang-outang? The more we study the subject, the more abundant reason do we find for assigning him a place in creation altogether separate and distinct. As we said before, he stands alone; he possesses a nature far more exalted than that of the bird or the beast; he occupies at present a higher position, and we feel assured that he is destined in the future to fulfil a nobler end.

When we direct our attention to the records of former ages, and search for their fossil remains, we come to the farther and still more remarkable conclusion, that man stands apart, not only from the creatures that at present people the globe, but from all the inconceivable multitude of genera and species that have ever lived upon the earth. In all the epochs that geology has explored, there is no trace of any creature possessing intelligence like that of the human race. There are no remains of the builder's toil, or of the potter's art. There is no trace of any implement fitted for accomplishing a destined end. There is nothing to indicate the presence of intelligence capable of directing the agencies of nature in order to lighten the workman's labour. There is no evidence of a master mind able to subdue the lower creatures to its will. Had such a mind existed in any bodily form, it must have left some proof of its operations, some relics of its power. We therefore conclude, that man is not to be classed with any inhabitant of the earth of which cognisance can be taken either by the science of the present, or by the science of the past.

Some speculate in regard to the organisation of his body and the size of his brain, and deduce from them the rank that man should hold. They point to what they term the course of creation, and speak of animals of the lower forms having been succeeded by others of a higher class in regular progression, till at last man, with "the reasoning brain," appeared on the scene. In all these speculations, however, reference is made only to the material framework of his body, and to the cerebral apparatus through which the animal faculties exert their powers. Attention is confined to that part of the human constitution in which he resembles the lower creation. The nobler portion of his nature, in respect of which he has no fellow in this terrestrial scene, is excluded from view. Man is spoken of as characterised by a more delicate organisation and a higher development; but no notice is taken of the rational and immortal principle which is superadded to the faculties of the animal nature, and intended for their guidance and control.

We, on the contrary, maintain, that man differs essentially from all other creatures here below, at once in his nature and in his destiny. Reason, conscience, and the other characteristics of the soul, raise him as far above the most intelligent of the irrational orders, as the living sentient principle raises the animal above the vegetable, and as the power of organic vitality raises the plant and animal above the stone.

It is perfectly true, that in the various classes of irrational creatures we find a gradual ascending scale of existence—we find a series of almost imperceptible steps, from the lowest zoophyte up to the most sagacious mammal; but it is not a mere step that separates man from the creatures below him, it is a gulf that cannot be measured. In the lapse of ages so numerous that it is impossible for us to conceive them, amid such a variety of species and genera, of every size and form, that the contemplation of them becomes perfectly overwhelming, there has not appeared a single creature with which man may be classed or compared. His nature and his position are altogether peculiar. He appears as a new thing on the earth. His entrance on the terrestrial scene marks out an era altogether distinct from those that preceded it; an era which is not to be regarded as the termination of a series of epochs that have run their course, but as the commencement of a period that has just begun. The teachings of science, when rightly understood, emphatically declare that man does not belong to the past, but to the future.

As to the design for which he has been brought into being, and as to the destiny which his future history shall disclose, philosophy is silent. Information in regard to these things must be derived from an altogether different source. Science completes its task, when it brings us to the threshold of the temple of things unknown, and commits us to the charge of the

High Priest ministering there. When we enter the sacred precincts, a higher intelligence than that of man must guide our steps, and point out to our admiring eye the wonders and the glories of the sanctuary within.

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